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Cross-Cultural Differences in Risk Perception: A Model-Based Approach

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The present study assessed cross-cultural differences in the perception of financial risks. Students at large universities in Hong Kong, Taiwan, the Netherlands, and the U.S., as well as a group of Taiwanese security analysts rated the riskiness of a set of monetary lotteries. Risk judgments differed with nationality, but not with occupation (students vs. security analysts) and were modeled by the Conjoint Expected Risk (CER) model.(1) Consistent with cultural differences in country uncertainty avoidance,(2) CER model parameters of respondents from the two Western countries differed from those of respondents from the two countries with Chinese cultural roots: The risk judgments of respondents from Hong Kong and Taiwan were more sensitive to the magnitude of potential losses and less mitigated by the probability of positive outcomes.

KEY WORDS: Risk perception; risk assessment; financial risk; cross-cultural differences; uncertainty avoidance.

1. INTRODUCTION

1.1. Reasons for Investigating Cultural Differences in Risk Perception

A widely known and important insight in the theory of negotiations is that differences between negotiating parties in the perception and/or valuation of some of the dimensions under negotiation open the door for integrative bargaining solutions.(3) Given the rapid globalization that commerce and trade are currently undergoing, it is also incontrovertible that cross-cultural negotiations will become ever more common. In combination, these two observations suggests that researchers as well as practitioners ought to search for systematic and predictable differences in the perceptions and/or values held by members of different cultures because such differences have potentially beneficial implications in the area of exchange. The current literature often emphasizes the negative consequences of cultural differences in perception, noting, for example,(4) that "[cultural] differences [in the calibration of probability judgments] suggest that cross-cultural miscommunication about uncertainty is virtually guaranteed" (p. 169). While differences in perception or value may indeed be a source of confusion and miscommunication, especially when negotiating parties are unaware of the possibility of such differences, they clearly also have constructive potential, especially if both parties are aware of the possibility and direction of such differences.

Differences in the perception of the value and/or the risk of risky options between different parties have direct implications for their exchange. Markowitz's(5) model of portfolio selection assumes that the decision maker will seek to minimize the risk of a portfolio for a given level of expected return. The early risk–return models of finance(5) equated risk with variance, a formalization that is compatible with a quadratic utility function for money.(6) Recent work(7–10) has shown, however, that a broad range of utility functions have risk–return interpretations. Different utility functions imply

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different measures of risk under the assumption of risk aversion and the equation of return with expected value.

These generalized risk–return models allow for the fact that the perception of the riskiness of risky options may differ between individuals or groups or may differ as a function of the decision context. Differences in the perception of the riskiness of options may then give rise to opportunities to trade options in ways that make both sides better off. As an example, assume party A holds an option whose possible payoffs have a high variance but are distributed symmetrically around the mean. Party B holds an option that is equal to that of party A in expected value, has smaller variance, but is negatively skewed. If party A perceives the riskiness of options to be proportional to their variance, but party B perceived it to be proportional to their downside potential, both parties would be better off by exchanging their options. They would achieve a reduction in perceived riskiness without any change in expected value or return. Even though risk–return models were developed to describe risky financial options, the notion of a risk–return trade-off readily generalizes to other domains, including health and safety risks.

1.2. Effects of Culture on Perception

Culture has been shown to dramatically influence a wide range of psychological processes. At the most basic perceptual level, members of different cultures have shown different susceptibilities to optical illusions and color perception.[11] Brislin[12] documented cultural variation in attribution processes, and cultural differences in the construal of the self and its relationship to others have been shown to have consequences for cognition, emotion, and motivation.[13] Closer to processes that may play a role in negotiations which often involve some uncertainty about outcomes on one or more dimensions, culture has also been shown to affect confidence judgments and calibration.[4,14]

Risk preference is a label used to describe a person's choice when faced with two options that are equal in expected value but differ on a dimension assumed to affect the riskiness of options, for example the variance of outcomes. Weber and Hsee[15,16] recently documented cross-cultural differences in risk preference for risky options involving either financial outcomes or gains or losses in working hours. They found that the preferences of Chinese respondents were significantly more risk-seeking than those of American or other Western respondents. However, differences in risk preference can arise in two qualitatively different ways. Weber and Milliman[17] showed that some people choose an apparently riskier option over an apparently less risky one because they have a positive attitude toward risk (i.e., are truly risk seeking); however, most people who show the same choice pattern choose the apparently riskier option because they have a different subjective impression of the relative risks of the two choice options (i.e., they perceive the option that they choose to be less risky and are, in fact, perceived-risk averse). The same has also been observed for cross-situational differences in risk preference. Mellers, Schwartz, and Weber[18] examined the well-known reflection effect, i.e., the fact that many people exhibit risk-averse preferences in the gain domain and risk-seeking preferences in the loss domain, where risk is equated with variance. By asking people both for their preferences between choice pairs in the loss and in the gain domain and for judgments about the relative riskiness of the two members of each choice pair, Mellers, Schwartz, and Weber found that of those people whose preferences reflected in the described fashion, only about half judged risk in similar ways in the two domains (as something proportional to variance) and truly had different perceived-risk preferences for gains than for losses. The other half, however, perceived risk differently in the gain than in the loss domain, and after controlling for those differences in perceived risk, had the same attitude toward perceived risk (i.e., tried to avoid it, by not choosing it, in both cases).

These results suggest that either differences in risk attitude or differences in risk perception can lie at the source of individual, cross-situational, and perhaps cross-cultural differences in risky choice behavior. Knowing the origin of such differences will be important to avoid cross-cultural misunderstandings and is crucial if one wants to capitalize on these differences, for example in cross-cultural negotiations. If different cultures perceive the riskiness of a set of options the same way, differences in choice will be indicative of differences in attitude toward risk. However, if there are systematic cultural differences in risk perception, differences in choice are no longer necessarily indicative of differences in risk attitude. Thus it is important to know whether there are cross-cultural differences in risk perception.

Section 2 provides a brief summary of the literature on risk perception as a psychological variable and on ways in which models have tried to capture differences in risk perception. Section 3 describes an empirical study of cross-cultural differences in the perceived riskiness of monetary lotteries. Section 4 describes the statistical analysis and model fits to the data, and Section 5 discusses the implications of our results.

2. MODELS OF RISK PERCEPTION

Risk perception is an important aspect of decision making under risk and uncertainty that has been shown to vary widely between individuals.[19,20] The need to model risk perception as a psychological variable with possible individual and cultural differences has given rise to two different approaches.

2.1. Axiomatic Models of Perceived Risk

The first approach attempts to model risk as a function of attributes of the alternative. Much of the work derives from Markowitz's normative treatment of risk,[5] which equated the riskiness of a decision with the variance of possible outcomes. Descriptive work has shown that people tend to weight positive and negative outcomes differently[21,22] and that these weights give rise to reference point effects not captured by variance or semivariance measures. In an effort to bootstrap on observed empirical regularities in the risk judgments provided by people, different axiomatic measures of perceived risk were suggested by Luce.[23] Based on additional empirical work,[24,25] Luce and Weber[1] suggested the conjoint expected risk (CER) model. The CER model captures both similarities in people's risk judgments (by a common functional form by which probability and outcome information of risky options is combined) as well as individual differences (with the help of model parameters that reflect the relative weight given to positive and negative outcome and probability information). Thus the perceived riskiness, R, of risky option X is described as:

$$\begin{aligned} R(X) = {} & A_0 \Pr(X = 0) + A_+ \Pr(X > 0) \\ & + A_- \Pr(X < 0) + \\ & B_+ E(X^{k+} \mid X > 0) \Pr(X > 0) + \\ & B_- E(X^{k-} \mid X < 0) \Pr(X < 0) \end{aligned} \tag{1}$$

i.e., is a linear weighted combination of the probability of breaking even, the probability of a positive outcome, the probability of a negative outcome, the conditional expectation of positive outcomes raised to the power of k_+, and the conditional expectation of negative outcomes raised to the power of k_-, where k_+ and $k_- > 0$. The CER-representation of perceived riskiness is the solution to a functional equation that is derived from a set of behavioral assumptions (i.e., axioms) about ordinal regularities among risk judgments,[1] and as the result of that, is not very "pretty." For example, some quantities (in particular the probability of positive and negative outcomes) appear twice in the representation, which means that parameters need to be interpreted in combination (e.g., A_+, B_+, and k_+ jointly determine the impact of positive outcomes on the overall perceived riskiness of alternatives). Nevertheless, Yates and Stone[26] recently described the CER model as the "most viable model to describe single-dimensional risk appraisal" (p. 72).

2.2. Psychometric Models of Perceived Risk

The second modeling approach treats risk as a multidimensional construct and uses multidimensional scaling, clustering, and factor analysis to identify the relevant psychological dimensions.[27–29] The psychometric paradigm has produced several important findings. The risk perceptions of lay people tend to differ systematically from those of experts. Members of the general public typically see greater risk in infrequent, catastrophic, and involuntary events and less risk in frequent, familiar, and voluntary events than is warranted by the long-run relative frequency of adverse consequences. While business or government experts may have clear quantitative definitions of the risks of products or technologies based on objective data or models, members of the general public often seem to evaluate the same options in very different ways. Much of the early work by Slovic, Lichtenstein, and Fischhoff[27] on psychological risk dimensions was, in fact, funded by the Nuclear Regulatory Commission to help them in their bafflement about how public perception of the riskiness of nuclear technology could differ so drastically from the estimates provided by their engineers. Using multidimensional scaling methodology, various groups of researchers have demonstrated cultural differences in the perception of the riskiness of activities that pose threats to health and safety. Applications have been reported using respondents from a range of countries, including France,[30] Hong Kong,[31] and Japan.[32]

2.3. Hybrid Models

Holtgrave and Weber[33] were concerned by the lack of connection between the axiomatic literature on the perception of financial risks, described in Section 2.1, and the psychometric literature on the perception of health and safety risks, described in Section 2.2. To remedy this situation, they took a set of risky activities that included both financial risks (e.g., "investing 80% of

savings in the stock of a new medical research firm'') and health and safety risks (e.g., ''riding a bicycle 1 mile daily in an urban area,'' or ''working on a special weapons and tactics police team'') and compared the fit of a simplified version of the CER model, originally developed to describe financial risk perception, with the fit of the psychometric risk dimension model by Slovic, Fischhoff, and Lichtenstein,[27,29] originally developed for the perception of health and safety risks. Respondents provided their overall evaluation of the riskiness of these different activities as well as evaluations of the component variables of the two models; five variables for the CER model: probability of a loss, a gain, or no change and expected loss or gain; and seven variables for the Slovic *et al.* model: voluntariness, dread, control, knowledge, catastrophic potential, novelty, and equity. Contrary to expectations, the CER model (with a smaller number of predictor variables) actually provided a better fit for the health and safety risks than for the financial risks (R^2 = .64 vs. .46) and also provided a better fit than the psychological risk dimension model for both financial risks (R^2 = .46 vs. .36) and health and safety risks (R^2 = .64 vs. .39).

Holtgrave and Weber speculated that the reason for the superior fit of the CER model might be that its dimensions of probability of negative consequences or harm and expected value of harm come close to the way people naturally think about the risk of a given activity or situation. Another reason might be that people consider the pros and cons of activities when judging riskiness; the CER dimensions of the probability of positive outcomes and the expected value of positive outcomes can counter the impact of negative outcomes. The psychometric model focuses exclusively on the downside of activities. Not surprisingly, a hybrid model that added three of Slovic *et al.*'s seven psychological risk dimensions (''dread,'' the degree to which the negative consequences of the risky options were dreaded, which accounted for most of the additional explained variance, but also ''catastrophic potential,'' the worst-case disaster severity of the activity, and perceived ''control,'' the degree to which the person engaging in the activity had control over the consequences) to the CER model turned out to do the best job in describing the risk perceptions of University of Chicago MBAs for financial risks. This suggests that risk perception of financial stimuli can have an ''emotional'' component for some observers that is not completely described by the ''objective'' components of the CER model.

The importance of Holtgrave and Weber's results[33] for the present paper is its demonstration that risk perception in different content domains can be captured by the same model, in particular the CER model used to model cross-cultural differences in risk perception in this paper. Palmer[34] also found recently that the simplified CER model provided excellent fits to risk judgments for both risky financial and health activities, including genetic testing. Thus it is at least plausible that reported cross-cultural differences in the perception of financial risks may also generalize to other risk domains.

2.4. Cultural Differences in the Perception of Financial Risks

While cultural differences in perceived risk for complex personal or societal activities have been studied widely using the psychometric paradigm, little is known about cultural differences in the perception of simpler (e.g., unidimensional) risks. Measurement models of risk perception, with the CER model as one of it's most promising examples, provide a means for examining such cultural differences. From a comparative standpoint, two basic hypotheses are of interest. The first one holds that the (functional) way in which people combine information about outcomes and probabilities is universal. This hypothesis predicts that a model like the CER model provides a good measure of risk regardless of cultural conditioning. Some evidence for this universal property comes from Palmer[34] who found that the CER model provided excellent fits to the risk judgments of students at University of California, Irvine, regardless of their cultural origin (Asian vs. American) or their worldviews (egalitarian, individualist, or hierarchist).

The second, related, hypothesis holds that differences in risk perception due to cultural conditioning will be reflected in systematic cultural differences in the parameters of a model like the CER model. This hypothesis predicts that variation in parameters across cultures will be larger than the variation within cultures. In the study described in Section 3, we obtained risk judgments from respondents in four different countries, designed to represent a range of social, religious, and historical experiences. Weber[21] found differences in the values of some of the CER model parameters between Canadian high-school teachers and U.S. undergraduate students. In particular, highschool teachers had significantly larger k-parameters, indicating that the magnitude of gains and losses played a larger role in their perceptions of risk than for the undergraduate students who were mostly responding to the probabilities of winning or losing. Unfortunately, in her study nationality and occupation were confounded. To test for occupational effects on risk perception and CER parameters in a more

systematic fashion, we included a comparison between Taiwanese security analysts and university students in our present study.

2.5. Correlates of Cultural Differences in Risk Perception

An important measure of behavior under uncertainty was provided by Hofstede.[2] As personnel director for IBM, Hofstede had the opportunity to analyze data from a values survey administered to 116,000 workers from over 40 countries. One factor that emerged from a factor analysis of these data was labeled Uncertainty Avoidance (UA) and was described by a reliance on formal procedures and experts, a preference for stability in the working environment, and susceptibility to stress. Hofstede identified UA, a variable measured and validated at the cultural (i.e., not individual) level, as an important source of cultural variation and proposed that cultures high in UA would tend to be less risk taking, in part because they are motivated by a fear of failure, as opposed to a desire to achieve success.

This interpretation suggests that the factors that result in cultural differences in UA might also affect decisions under risk. As discussed in Section 1.2, decisions or observable behavior under risk may differ in two groups either because they have different perceptions of the riskiness of choice alternatives (but share the same attitude, e.g., risk-aversion) and/or because they have different attitudes toward risk. Empirical data tend to favor the first alternative, namely differences in the perception of risk.[17,18] Hofstede's[2] interpretation of uncertainty avoidance thus suggests that UA should affect risk perception and that, in particular, for respondents from cultures with greater scores on UA, risk perception should be affected more by potential losses and less by potential gains. Translated into parameter differences in the CER model, greater salience of potential losses should be reflected in larger weights for the probability and magnitude of loss components and/or smaller weights for the (risk-reducing effects of the) probability and magnitude of gains. Thus, we hypothesized that cross-cultural differences in UA scores would be associated with systematic parameter differences in the CER model fits of the risk judgments of respondents from the four countries.

The values on Hofstede's[2] age-adjusted index of uncertainty avoidance for the countries represented in the present study are as follows. The United States ranked lowest with a score of 36, followed by the Netherlands with a score of 45; the two Asian countries had the two highest ranks, with Hong Kong scoring 61, and Taiwan scoring 73. The UA index has a mean of 64, and lower scores are indicative of less uncertainty avoidance.

3. METHOD

3.1. Participants

Respondents were undergraduate students at large universities in the U.S. (n = 100), the Netherlands (n = 25), Hong Kong (n = 60), and Taiwan (n = 156). The students participated in the study as part of a course requirement in either psychology or business. A sample of Taiwanese security analysts (n = 50) responded to the questionnaire during a continuing education training program.

3.2. Procedure

The risky choice alternatives presented in this study were monetary lotteries. Thirty lotteries were constructed using the transformation procedure described by Weber,[24] which takes a basic lottery and submits it to various transformations that change its expected value, variance, and skewness. These transformations generated the 30 three-outcome options shown in Table I, which were shown to a respondent one at a time. The total set of options was presented three times, each time in a different random order.

Respondents were asked to rate the riskiness of each option on a scale from 0 to 100. They were told that in evaluating the gambles they should consider a situation of playing the gamble and to decide intuitively how much risk they would be taking if they did so. It was stressed that they were to rate the risk of the gamble and not whether they would want to play it. Before evaluating the lotteries, respondents were shown five practice gambles chosen to cover the range of positive and negative outcomes and low and high probabilities included in the 30 gambles. These practice gambles were designed to help respondents use the full range of the risk response scale.

3.3. Translations

To translate instructions and stimuli, we followed the method known as back-translation with decentering.[35] The stimuli, originally written in English, were translated into the target language by bilinguals. Different bilinguals translated the instrument back into English. The two English versions were compared, and

Table I. Description of Three-Outcome Lotteries (Outcome Amounts Shown in U.S. Dollars) and Mean Risk Judgments by Nationality (Netherlands, United States, Hong Kong, Taiwan) and Occupation (Undergraduate, Security Analyst)

Lottery no.	Lottery description						Mean risk judgments				
	(O_1,	p_1;	O_2,	p_2;	O_3,	p_3)	NE	US	HK	TA_u	Ta_s
1	12.60	.01	4.70	.20	−3.30	.79	60.2	62.8	64.5	57.7	58.9
2	37.90	.01	14.00	.20	−9.80	.79	64.3	64.2	58.9	58.3	59.3
3[a]	138.80	.01	51.50	.20	−35.90	.79	67.3	66.0	60.3	62.6	61.1
4	5.60	.11	0.30	.44	−5.00	.45	49.0	53.7	53.9	54.9	53.6
5	16.70	.11	0.80	.44	−15.10	.45	51.2	55.1	55.9	59.0	57.6
6	61.30	.11	2.90	.44	−55.40	.45	58.4	59.2	57.2	62.1	60.7
7	2.60	.36	−2.50	.48	−7.60	.16	60.7	60.0	62.1	60.8	61.2
8[a]	7.70	.36	−7.60	.48	−22.90	.16	60.4	67.0	67.0	63.2	65.4
9	28.40	.36	−27.80	.48	−83.80	.16	70.3	75.0	73.0	73.5	73.1
10[a]	1.40	.56	−4.40	.38	−10.16	.06	52.5	60.4	63.4	61.6	64.1
11	4.20	.56	−13.10	.38	−30.50	.06	59.5	61.8	64.2	64.4	64.1
12	15.30	.56	−48.20	.38	−111.80	.06	65.1	69.2	70.7	71.4	70.4
13[a]	0.30	.79	−7.70	.20	−15.60	.01	51.4	49.4	45.8	47.7	46.4
14	0.90	.79	−23.00	.20	−46.90	.01	55.3	60.6	61.0	62.8	61.8
15[a]	3.00	.79	−84.50	.20	−172.00	.01	55.9	63.9	66.2	66.8	67.7
16	15.40	.01	7.50	.20	−0.50	.79	41.1	38.3	40.2	40.8	40.5
17[a]	46.30	.01	22.40	.20	−1.40	.79	50.6	44.8	43.0	38.9	38.1
18[a]	169.80	.01	82.30	.20	−5.20	.79	51.4	59.5	57.0	60.0	60.5
19	8.40	.11	3.10	.44	−2.20	.45	39.8	40.3	37.9	38.4	39.3
20	25.10	.11	9.20	.44	−6.70	.45	40.2	41.1	36.8	38.6	39.4
21[a]	92.10	.11	33.70	.44	−24.60	.45	42.1	43.0	36.5	37.7	35.1
22	5.40	.36	0.30	.48	−4.80	.16	30.4	34.0	34.0	35.0	34.8
23	16.20	.36	0.80	.48	−14.50	.16	35.4	38.1	34.2	37.7	36.6
24	59.20	.36	3.10	.48	−53.00	.16	36.1	41.8	37.0	41.2	40.9
25	4.10	.56	−1.60	.38	−7.40	.06	45.6	48.9	46.2	45.6	45.9
26	12.60	.56	−4.70	.38	−22.10	.06	43.1	46.7	43.0	43.6	44.1
27	46.10	.56	−17.40	.38	−81.00	.06	52.8	57.2	54.6	52.7	53.6
28[a]	3.10	.79	−4.90	.20	−12.90	.01	38.6	44.8	44.8	44.8	45.7
29	9.20	.79	−14.60	.20	−38.50	.01	42.2	46.8	46.0	47.0	46.1
30	33.80	.79	−53.70	.20	−141.20	.01	46.0	54.1	52.5	51.5	52.6
					Means across lotteries		50.7	53.6	52.3	52.7	52.6

[a] Denotes that between-group differences are significant at the .05 level.

discrepant passages retranslated. The conversion of the monetary values of the gambles posed a different problem. In the case of Hong Kong and Taiwan, estimates of weekly living expenses of college students in each country were compared to those in the U.S. to give a rough approximation of the buying power, and hence the relative value, of each country's currency. In the case of Holland, translation of the dollar amounts into Dutch Guilders by this method resulted in the same conversion factor as the current market rate.

4. RESULTS

4.1. Differences in Risk Judgments

A repeated-measures analysis of variance (ANOVA) of the risk judgments as a function of the nationality of the respondents was conducted with two purposes. The first purpose was to detect differences in scale use. The second purpose was to indicate whether or not there was any cultural variation in risk judgments for the CER model to detect. A *main effect* of nationality would indicate either that members of some nationalities generally perceive financial risks to be greater or smaller than other nationalities or that they interpreted the numerical rating scale in a systematically different way. An *interaction* in the risk ratings between nationality of the respondents and particular lotteries being evaluated would indicate that there are systematic cultural differences in the perception and thus definition of risk, in the sense that different components of risk (e.g., the probability of a loss or the magnitude of a loss) contribute to the perceived overall riskiness in culture-specific ways. The ANOVA resulted in a significant main effect for lottery ($F(29,9831) = 190.81, p < .00001$), and also

Table II. Average CER Parameters by Nationality and Occupation[a]

	Students				Security analysts
Parameter	Netherlands	U.S.	Hong Kong	Taiwan	Taiwan
A_+	5.41[a]	9.64[ab]	11.56[ab]	16.75[b]	20.33[b]
A_-	−10.33	−11.86	−5.78	−8.77	−6.99
B_+	−14.95	−14.48	−15.84	−18.66	−16.53
B_-	14.13[a]	7.18[a]	1.91[b]	1.20[b]	3.28[b]
k_+	.26	.43	.54	.33	.28
k_-	.55[a]	1.10[b]	1.49[b]	1.18[b]	1.46[b]

[a] Means identified by different superscripts are significantly different from each other at the .05 level.

a significant lottery by nationality interaction ($F(87,9831) = 2.93$, $p < .0001$). The main effect for nationality was not significant ($F(3,377) < 1$). Analyses of the risk ratings for individual lotteries showed significant differences as a function of nationality for nine of the 30 lotteries at the .05 level. Those lotteries are marked in Table I. The risk ratings of the two groups of Taiwanese respondents did not differ significantly from each other ($F(1,203) < 1$).

Visual inspection of the mean risk judgments of the 30 lotteries for the different groups of respondents shows that the pattern of differences in risk perception between nationalities is not easily discernible. For some lotteries (e.g., lottery 3), mean risk judgments are greater for respondents from the Netherlands and the United States; for other lotteries (e.g., lottery 15), mean risk judgments are greater for respondents from the three Asian samples.

4.2. Differences in CER Model Parameters

To obtain a more easily interpretable summary of the nature of the cultural differences in risk perception, the CER model was fit to the risk judgments of each respondent. The parameters of the CER model were estimated separately for each respondent using the secant method of computation in the SAS NLIN procedure. Since none of the gambles in the set had zero outcomes ($0), only six parameters (A_+, A_-, B_+, B_-, k_+, and k_-) needed to be estimated. The goodness of fit index of the model was consistently high across all countries. For the Netherlands, the United States, Hong Kong, and the two Taiwan samples, respectively, the average coefficients of determination were .89, .91, .92, .91, and .89. These individual-subject model fits generated a distribution of values for each parameter in each culture, and the means of these parameter value distributions are shown in Table II.

A repeated-measures ANOVA was conducted using the six CER parameters estimated for each respondent as the dependent variables and nationality as the independent variable. The null hypothesis of no difference in CER parameters across cultures was rejected ($F(18,939) = 3.38$, $p < .0001$). The effect of nationality in the univariate ANOVAs of each CER parameter was significant for A_+ ($F(3,337) = 2.58$, $p < .05$), B_- ($F(3,337) = 5.31$, $p < .001$), and k_- ($F(3,337) = 2.89$, $p < .05$). The effect was not significant for A_-, B_+, and k_+. A repeated-measures ANOVA of the six CER parameter for the Taiwanese respondents as a function of their occupation (undergraduate student vs. security analyst) showed no significant difference overall, and none for any of the parameters in separate univariate ANOVAs.

The results of the two analyses (by nationality and by occupation) are summarized in Table II. Parameter values that differed significantly from each other are indexed by different letter superscripts. The value of k_-, the power coefficient to which negative outcomes are raised in the CER model, was smallest for respondents from the Netherlands and significantly different from that of the other four groups of respondents (as indicated by superscripts *a* vs. *b*), which in turn did not differ significantly from each other with respect to k (as indicated by the same superscript *b*). The value of k_+, the power coefficient to which positive outcomes are raised, on the other hand did not differ significantly among the five groups (as indicated by the absence of any superscripts).

As mentioned in Section 2.1, in the CER-model groups of parameters need to be interpreted in combination. Parameters A_+, B_+, and k_+, in combination, determine the impact of positive outcomes on the perception of the overall riskiness of a lottery. Parameter k_+, the power coefficient to which positive outcomes are raised, was not significantly different for the four cultures and had a value of around .4, indicating that the magnitude of positive outcomes was much discounted by all four groups in the determination of the overall riskiness of an option. The probability of positive outcomes enters twice into the CER function (see Eq. 1); once as the sum of the probabilities of all positive outcomes where it is weighted by parameter A_+; the other time as a multiplicative discount factor for the impact that the magnitude of that outcome has on perceived riskiness of the option, in the conditional expectation of positive outcomes, where the expression is weighted by parameter B_+. The combination of the A_+ and the B_+ components of the CER equation determines the net effect of positive outcomes on perceived risk. Parameter

B_+ was negative and not significantly different for the four cultures, indicating that the magnitude of the conditional expectation of positive outcomes reduced risk for all four cultures by approximately the same amount. Parameter A_+ was positive for all four cultures, indicating that the magnitude of the probability of positive outcomes added to the overall riskiness of the option, or rather, reduced the reduction in perceived risk as a function of positive outcomes expressed by the B_+ component of the CER equation. Larger values of A_+ (as for the two Taiwanese samples) have the result that more of the reduction in risk signaled by B_+ is canceled out, i.e., positive outcomes, overall, have less of a risk reduction effect.

The values of A_+ shown in Table II have approximately the same rank order as the country uncertainty avoidance (UA) indices discussed in Section 2.5. The two Western countries have values of both *UA* and A_+ that are smaller than the corresponding values of the two Asian countries; and in both cases, the values of Hong Kong are intermediate to the values of the two Western countries and Taiwan. Positive outcomes had a significantly smaller (perceived risk-reducing) effect for the two Taiwanese samples than for the two Western samples, and an intermediate effect for the Hong Kong sample. The similarity in rank order between the impact of positive outcomes and uncertainty avoidance is at least consistent with Hofstede's[2] hypothesis that countries high in uncertainty avoidance are motivated less by a desire to achieve success.

Parallel to the discussion about the effect of gains on risk in the last two paragraph, the impact of negative outcomes on the perception of the overall riskiness of risky options also requires a consideration of several parameters (A_-, B_-, and k_-) in combination. Parameter k_-, the power coefficient to which negative outcomes are raised, was significantly different for the four cultures and less than 1 only for the Dutch sample, indicating that the magnitude of negative outcomes had more impact on the perceived riskiness of an option for the American and the Asian samples. Parameter B_-, the weight of the conditional expectation of negative outcomes, was also significantly different for the four cultures, with larger values for the two Western samples. Some of the risk-enhancing impact of negative outcomes expressed by the B_--component is reduced by the A_--component (since A_- is negative), but this reduction is the same for all four cultures (since A_- does not differ significantly between cultures). In combination, these differences in country parameter values mean that the risk perception of the two Western samples (and in particular of the Dutch sample) is less affected by the *magnitude* of negative outcomes (smaller values of k_-) and more by their *probability* (larger positive, risk-enhancing, values of B_-).

In combination, the cultural differences in parameter values related to negative outcomes mean the following. For respondents from the two Western countries, risk was affected more by the probability of losses than by their magnitude. The opposite was true for respondents from the two Asian countries. Thus, Dutch and American respondents should perceive greater risk than the Asian respondents for lotteries with a large probability of small losses, which is born out by the mean risk judgments for the five samples for such lotteries in Table I (see, for example, lottery 3). Conversely, Asian respondents should perceive greater risk than Western respondents for lotteries with a smaller probability of larger losses, which can also be found in Table I (see, for example, lottery 15).

5. DISCUSSION

The lack of a main effect for nationality on risk judgments indicated that there was no general tendency for respondents from different countries to use the risk rating scale in systematically different ways, even though such cultural differences in scale usage have been identified in other contexts.[35] The significant lottery-by-nationality interaction indicated, however, that different elements of risky options were weighted differently by respondents from different cultures. The decomposition of risk judgments into CER model components allowed us to further identify the locus of these cultural variations in risk perception. Model fits were high and did not differ systematically across countries, indicating that the functional form of the CER-model provides a good measure of perceived risk across cultures. The systematic differences in A_+, B_-, and k_- as a function of nationality show that variation in these parameters across countries is larger than the variation within countries.

Cross-cultural differences in model parameters followed an Asian–Western division. Differences in parameters were generally greatest between the Netherlands and Taiwan, with the American and Hong Kong parameters intermediate. The two Western countries, the Netherlands and the U.S., differed significantly on only one parameter, k_-. Taiwan and Hong Kong, the two countries with a common Chinese cultural heritage, did not differ significantly on any of the CER-model parameters. The direction and interpretation of cultural differences

in CER parameters were generally consistent with the countries' scores on uncertainty avoidance as measured by Hofstede.[2] These results suggest that cultural variation in relative emphasis on fear of failure vs. a desire to achieve success, hypothesized by Hofstede to result in differences in uncertainty avoidance, may also result in systematic differences in the perception of risk. Positive outcomes had a smaller (reducing) effect on perceived risk for the Taiwanese than for the two Western samples, with an intermediate effect for Hong Kong. Cultural differences for the effect of negative outcomes were somewhat more complex. While the probability of a loss had a larger effect on risk for the two Western samples, the magnitude of the losses had a larger effect on the risk perceptions of the Asian respondents.

Cross-cultural differences in risk perception were greater than differences due to occupation. The CER-model parameters of Taiwanese students were not significantly different from those of Taiwanese security analysts, suggesting that cultural upbringing and environment may play a greater role in shaping the perception of financial risks than professional training or expertise. In other words, the fact that respondents from two local cultures within Taiwan had very similar perceptions of the riskiness of financial options which, in turn, differed from those of respondents from different global cultures suggests that risk perception is shaped less by current situational influences, incentives, or loss functions and more by the larger, more stable, and more longstanding cultural environment.

Our results should be generalized with some caution, since our respondents were not random samples from each society. In each country, they were undergraduate students at a large university, with an additional convenience sample of security analysts from Taiwan. It might be argued, however, that the effect of a higher education would be to reduce national and cultural differences and that true random samples from national populations might reveal even larger cultural differences in risk perception.

McDaniels and Gregory[36] recently laid out a thoughtful and comprehensive framework for structuring cross-cultural research in risk and decision making in which they categorize existing and future research along several dimensions. The first one concerns the level of comparison, which can be either individual, organizational, or governmental. Clearly, our study falls into the first category, but suggests straightforward generalizations to the second level, e.g., to risk perception and risky choice in (business) organizational settings.[37] McDaniels and Gregory also classify the existing research by the disciplinary background of the investigators, with cognitive psychologists paying particular attention to the processes by which people arrive at decisions under risk and uncertainty. In this spirit, Weber and Bottom[21] first suggested that individual (and cultural) as well as situational differences in risky choice may either be mediated by differences in risk attitudes or by differences in risk perception, which means that perceived-risk attitudes may actually be the same (for the most part, perceived-risk averse) even though choices differ. Weber and Hsee[15] found that the latter explanation, i.e., cultural differences in risk perception but not in perceived-risk attitude, explained cross-cultural differences in maximum buying prices for risky financial options between respondents from Germany, Poland, the People's Republic of China, and the United States. The present study confirms, using different national samples, that there are systematic national and cultural differences in people's perception of the overall riskiness of risky financial options.

McDaniels and Gregory[36] end their survey of the currently sparse field of cross-cultural research on risk by urging researchers to put more emphasis on the prescriptive implications of their research, posing questions such as the following (p. 106): "How could what is done now be done better by learning something about a different culture?" In this spirit, we suggest that the results of our study have the following prescriptive implication. As Yates *et al.*[4] noted, systematic cultural differences in risk perception could lead to difficulties in interpersonal communication across cultures. Particularly in an exchange or bargaining relationship, individuals may wrongly generalize their own perceptions of risk to the other party (the false consensus effect) and misinterpret disagreements as signs of uncooperativeness or strategic behavior. Given the results of our study, the likelihood of this miscommunication is clearly greater across cultures. On the other hand, if the negotiating parties are open to the possibility that differences in risk perception might exist, and if they explore the other side's perceptions about risks and returns of available alternatives, existing differences represent an opportunities for joint gains. Given the cultural differences in risk perception observed in this study, risk minimizing exchanges can be expected to have a greater likelihood in cross-cultural exchange rather than within-cultural exchange. This suggests that traders and negotiators ought to be alerted to existing work about the nature and direction of differences in risk perception between members of their own culture and members of the culture of their negotiation or trading partners.

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