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Discussion paper

Prospect Theory around the World

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Prospect Theory around the World

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Abstract

We present results from the first large-scale international survey on risk preferences, conducted in 45 countries. We show substantial cross-country differences in risk aversion, loss aversion and probability weighting. Moreover, risk attitudes in our sample depend not only on economic conditions, but also on cultural factors, as measured by the Hofstede dimensions Individuality and Uncertainty Avoidance. The presented data might also serve as an interesting starting point for further research in cultural economics.

Keywords: Risk preferences; prospect theory; cross-cultural comparison.

JEL classification: D90, F40

1 Introduction

Risk preferences are a key determinant of economic behavior. They determine for example the degree of insurance households buy, are decisive for their assets allocation decisions, and are a key determinant of firms' cost of capital. Research on risk preferences has therefore been at the center of economics in general and of finance in particular.

The purpose of our study is to analyze whether there are international differences between risk preferences and if so whether they correlate with economic or cultural factors. Those differences are certainly important for

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institutions offering insurance and investment products in multiple countries and they might also help to explain international differences in the cost of capital.

Previous studies have shown that there is a substantial amount of variation between subjects from different countries on risk perception, risk attitudes and probabilistic thinking. In particular, it is found that countries with collectivistic cultural traditions tend to perceive less financial risks and appear to be less risk-averse (e.g.,Bontempo, Bottom & Weber (1997), Hsee & Weber (1999) and Wang & Fischbeck (2008)). The "cushion" hypothesis is proposed to explain such phenomena: the strong social network in the collectivistic society provides a certain kind of "cushion" against the potential financial catastrophe, and therefore induce more risk-seeking behavior. Researchers also find East-Asian subjects tend to be more overconfident in probability judgement (Yates, Zhu, Ronis, Wang, Shinotsuka & Toda 1989, Yates, Lee, Shinotsuka, Patalano & Sieck 1998, Wang & Fischbeck 2008), which can be contributed to early education style (Bontempo et al. 1997, Hsee & Weber 1999, Renn & Rohrmann 2000).

The research question of our study is whether the variation between countries is systematic and can be explained by macroeconomic or cultural factors. We find substantial cross-country differences in risk aversion, loss aversion and probability weighting. Moreover, risk attitudes in our sample depend not only on economic conditions, but also on cultural factors, as measured by the Hofstede dimensions Individuality and Uncertainty Avoidance.

2 Methodology

The question of how to measure risk preferences has been addressed using quite different research methodologies. Most prominently are laboratory experiments that infer risk preferences from individuals' choices between simple lotteries. These experiments have shown that there are persistent discrepancies between predictions of rational models (expected utility theory) and empirical data (see Starmer (2000) for a survey on this issue).

2.1 Participants

In this article, we present results from an international survey of economics students from 45 countries, the International Test on Risk Attitudes (INTRA), that was conducted by the University of Zurich, Switzerland, in collaboration with various universities worldwide.

The survey was conducted with undergraduate students at 53 universities. A total of 5,912 university students participated in our survey. Most participants were first or second-year students from departments of economics, finance and business administration. The average age of participants was 21.5 years (SD=3.82), 52% were males.

2.2 Questionnaire and procedure

Each participant was asked to fill in a questionnaire that included 14 decision making questions (three time preference questions, one ambiguity aversion question, and 10 lottery questions that were used to estimate prospect theory parameters), 19 questions from the Hofstede VSM94 questionnaire (Hofstede & McCrae 2004), a happiness question and some information about their personal background, nationality and cultural origin. The questionnaire (see appendix for a sample questionnaire) was translated into local languages for each country by professional translators or translators with economic background. The amount of monetary payoffs in the questions were adjusted according to each country's Purchasing Power Parity and the monthly income/expenses of the local students and the local currency was used. The participants were instructed that there are no wrong or correct answers to these questions, and that the researchers are only interested in their personal preferences and attitudes. In most cases, the survey was conducted during the first 15 to 20 minutes of a regular lecture under the monitoring of the local lecturers and experimenters. The response rate was therefore very high (more than 90%).

There could be two major concerns about our survey methodology:

First, we only used university students as subjects, not a representative sample of the total population. There are, however, several advantages of this sample selection:

1. First and second year economic students understand better the numeric formulations of lottery and time preference questions than the general public, but can still answer the questions intuitively.

2. Students from economics can also be expected to play an important role in economics and financial markets in each country and in the global market. The time and risk preferences we study here are relevant for those finance-related activities.

3. As Hofstede (1991), a leading researcher in cross-cultural comparisons, emphasized: to make a cross-national comparison, it is important to recruit homogeneous, comparable groups from each country in order to control the background variables as much as possible.

Second, it might be that, since we only asked hypothetical questions without offering real monetary incentives, participants may not be motivated to give thoughtful answers. However, researchers who compared directly the real and hypothetical rewards did not find systematic differences, e.g., Johnson & Bickel (2002). This was confirmed in a pilot study at the University of Zurich that we conducted in class (without incentives) and in the laboratory (with monetary incentives following the BDM procedure (Becker, Degroot & Marschak 1964)). No significant differences were found between the monetary-incentive group versus the hypothetical-question group.

In any case, these concerns are in our opinion far outweighed by the possibility to obtain a large sample without the usual self-selection bias that surveys frequently show.

We measured risk preferences by eliciting the participants' willingness to pay for hypothetical lotteries with survey questions like the following:[1]

Imagine you are offered the lotteries below. Please indicate the maximum *amount you are willing to pay for the lottery:*

40% chance	*win $0*
60% chance	*win $100*

I am willing to pay at most $____ to play the lottery.

Six of the lotteries were solely about gains with different probabilities (where one of the lotteries had a very high gain), two were solely about losses. The remaining two lotteries were mixed lotteries. Here the elicitation was different:

In the following lotteries you have a 50% chance to win or lose money. The potential loss is given. Please state the minimum amount $X for which you would be willing to accept the lottery.

50% chance	*loss of $100*
50% chance	*win of $X*

X should be at least $____ to make the lottery acceptable.

Table 1 summarizes the ten lotteries in the questionnaire.

Finally, we need to mention one peculiar issue: the survey was conducted mainly in the years 2008/2009. This might raise concerns about a potential impact of the global financial crisis on risk preferences. We cannot exclude such an impact entirely, but fortunately, if there was an impact, it must have been smaller than the between-country variations that we measured, since we did not find any statistically significant difference between the data collected before and after the onset of the financial crisis. This might be due to the fact that we did not frame our questions as investment, but as (more neutral) lottery questions.

3 Preference models and descriptive results

3.1 Prospect theory in parametric form

The probably most widely used models for decision under risk are expected utility theory (as a normative model) and the various variants of prospect

[1]See the appendix for a complete sample questionnaire.

Table 1: Design for the ten lotteries in INTRA.

Lottery	Outcome A($)	Prob(A)	Outcome B($)	Prob(B)	Average Value ($)
1	10	0.1	100	0.9	91
2	0	0.4	100	0.6	60
3	0	0.1	100	0.9	90
4	0	0.4	10,000	0.6	6000
5	0	0.9	100	0.1	10
6	0	0.4	400	0.6	240
7	-80	0.6	0	0.4	-48
8	-100	0.6	0	0.4	-60
9	-25	0.5	-	0.5	-
10	-100	0.5	-	0.5	-

theory (as a descriptive model). In this article we present results for cumulative prospect theory with the classical specification of (Tversky & Kahneman 1992) and expected utility theory with constant relative risk aversion. The two models are given as follows:

$$CPT = (1 - w(p))v(A) + w(p)v(B),$$
$$EUT = (1 - p)u(A + W) + pu(B + W),$$

where A and B are the payoffs of the lottery ($A < B$), p is the probability to obtain the higher outcome B, w is the probability weighting function, v the value function, u the utility function (which we choose to be CRRA to be close to the CPT model) and W the initial wealth (which is also unobserved and has therefore to be estimated). w and v are given by:[2]

$$v(x) := \begin{cases} x^\alpha, & x \geq 0 \\ -\lambda(-x)^\beta, & x < 0, \end{cases} \tag{1}$$

where $\lambda > 0$ is called the "loss-aversion" coefficient, and $\alpha, \beta > 0$ (usually $\alpha, \beta \leq 1$) describe the risk-attitudes for gains and losses.

The standard weighting function is

$$w(p) := \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{1/\gamma}} \tag{2}$$

with the parameter $\gamma \in (0, 1]$ describing the amount of over– and underweighting. Originally, the weighting function had been allowed to have different parameters in gains and losses (Tversky & Kahneman 1992). Given, however, that many previous studies find very similar weighting functions in gains and losses, e.g. Tversky & Kahneman (1992), Camerer & Teck-Hua

[2] We tried different specifications of w and v and also alternative prospect theory models, but we do not focus on this in the current article, see Rieger & Bui (2011) for details.

(1994) and Tversky & Wakker (1995), and to keep the model as parsimonious as possible, we modeled w in the same way and with the same parameter γ for gains and losses.

Prospect theory is characterized by four important deviations from expected utility theory: First, payoffs are evaluated with respect to a fixed reference point ("gains" and "losses") and not in terms of final wealth. Second, risk preferences differ in gains and losses which is expressed by the convex-concave shape of the value function v. Third, losses loom larger than gains, which is expressed by the loss-aversion λ (typically larger than one) that leads to a steeper value function in losses than in gains. Fourth, small probabilities have overly large decision weight, as expressed by the nonlinear probability weighting function w.

A direct comparison of the two models in our sample revealed that expected utility theory is a reasonable descriptive model only for a minority of subjects – which is in accordance to many other previous studies: 80.4% of all subjects showed risk-seeking behavior in losses and risk-averse behavior in gains, as prospect theory would predict, and 74.5% show loss-aversion.

Estimating prospect theory parameters for single persons is a difficult task that needs a large amount of lotteries to get at least somehow reliable results. More frequently, parameters are estimated for median answers of a group of subjects. We did such estimates for the subjects of each participating country. For the computation we used a grid search method. With this we estimated the parameters for the weighting function and value functions by minimizing the sum of normalized errors for the first eight lotteries, where the parameter values of α, β, γ varied from 0 to 1. The error function was defined as the sum of the absolute differences between the CE and the maximum outcomes of the lotteries. The normalized errors are the proportion of those differences and the lottery's maximum outcome for each lottery.[3] Since the loss-aversion parameter λ depends very sensitively on the ratio between α and β, it is better to report the more robust parameter θ which has been defined by Tversky & Kahneman (1992) as the ratio between a gain A and a loss B such that a fifty-fifty lottery between A and B is as attractive as an outcome of zero. We can compute this parameter easily from our lotteries 9 and 10, if we divide X by the potential loss (25 or 100, respectively). The reported value θ is the average of these two numbers.

The resulting prospect parameter estimates α, β, γ and θ are reported in Table 2. We can see at first glance a couple of interesting facts:

- The estimated values are reasonably close to previous estimates (compare, e.g., Rieger & Wang (2008) for an overview).

[3]The parameter λ does only influence preferences in mixed lotteries, thus we do not have to assume anything about λ while estimating the other three parameters from the lotteries 1–8.

Table 2: Estimated cumulative prospect theory parameters for the median answers of each country.

	Prospect theory (based on median CEs)			
	α	β	γ	θ
Angola	0.60	1.00	0.60	1.45
Argentina	0.60	1.00	0.70	1.09
Australia	0.60	0.95	0.60	1.24
Austria	0.40	0.95	0.65	1.62
Azerbaijan	0.60	1.00	0.65	1.23
Bosnia/Herzegovina	0.65	0.90	0.45	1.00
Canada	0.50	1.00	0.50	2.00
Chile	0.55	1.00	0.65	2.00
China	0.60	1.00	0.60	1.83
Colombia	0.40	1.00	0.35	2.00
Croatia	0.60	1.00	0.45	2.33
Czech Republic	0.60	1.00	0.55	2.00
Denmark	0.50	1.00	0.65	2.00
Estonia	0.50	1.00	0.35	4.00
Georgia	0.55	1.00	0.60	5.50
Germany	0.45	1.00	0.50	2.00
Greece	0.65	0.80	0.50	2.00
Hong Kong	0.40	1.00	0.30	2.43
Hungary	0.50	1.00	0.45	2.00
Ireland	0.50	1.00	0.45	2.00
Israel	0.58	0.95	0.35	1.99
Italy	0.45	1.00	0.50	2.46
Japan	0.45	1.00	0.60	2.00
Lebanon	0.53	0.95	0.25	1.74
Lithuania	0.55	1.00	0.35	2.00
Malaysia	0.58	1.00	0.60	1.50
Mexico	0.40	1.00	0.35	1.50
Moldova	0.65	0.95	0.65	3.44
New Zealand	0.65	0.95	0.50	1.50
Nigeria	0.75	1.00	0.50	2.00
Norway	0.55	1.00	0.55	1.83
Portugal	0.50	1.00	0.65	1.83
Romania	0.50	1.00	0.60	3.33
Russia	0.53	1.00	0.33	3.00
Slovenia	0.55	1.00	0.40	2.12
South Korea	0.60	0.95	0.70	1.37
Spain	0.45	1.00	0.60	2.38
Sweden	0.50	1.00	0.65	2.00
Switzerland	0.45	1.00	0.50	2.00
Taiwan	0.55	0.95	0.53	2.00
Thailand	0.65	0.90	0.55	3.00
Turkey	0.60	1.00	0.65	1.80
UK	0.50	1.00	0.50	1.38
USA	0.58	1.00	0.43	1.65
Vietnam	0.60	1.00	0.55	1.75

- α is significantly smaller than β, i.e. the median subject is quite risk neutral in losses, and risk averse in gains.
- The median response in almost all countries indicates loss aversion.
- The heterogeneity between countries is high. Below, we investigate this point in more details.

3.2 Prospect theory and relative risk premia

The parametric approach has provided us with a bird's eye view on the distribution of prospect theory preferences across the world. For a more detailed analysis, however, we need to use the data on a subject level. This needs a new approach, since the prospect theory parameter estimation is not stable enough to give reliable results for each subject: the estimation procedure is highly nonlinear and extremely sensitive to noise. One exception is the loss-aversion parameter θ which is robust and can also be used on an individual level.

To solve the robustness problems, we propose therefore a different set of parameters that captures the essential features of prospect theory. The key idea is to compute relative risk premia for the lotteries 1–8 and derive from them three factors, corresponding to risk aversion in gains, risk seeking in losses and probability weighting. To do so, we will use two different methodologies, giving us a solid confirmation for later analyses:

First, we compute the relative risk premium (RRP) for each lottery question via the standard formula

$$RRP = \frac{EV - CE}{EV},$$

where EV is the expected value of the lottery and CE denotes the certainty equivalent, i.e. the value that has been chosen by the subject.

The RRP is positive whenever a person is risk-averse and negative when it is risk-seeking. As we have already pointed out, for the majority of subjects the RRP is positive in gain lotteries (lottery 1–6) and negative in loss lotteries (lottery 7+8). Based on the RRP for these lotteries we can now define three parameters that measure the essential ideas of prospect theory:

1. The *RRP in gains* is defined by taking the average RRP over the lotteries 1–6. This corresponds to the risk-aversion parameter α in prospect theory (but with opposite direction: larger RRP means *more*, not less, risk-aversion).
2. The *RRP in losses* is defined by taking the average RRP over the lotteries 7+8. This corresponds to the risk-seeking parameter β in prospect theory.

3. The *RRP probability weighting* is defined as the difference between the RRP of the lottery 3 (with a 90% chance to win) and the lottery 5 (with a 10% chance to win). Probability weighting will make lottery 3 less attractive (high RRP) and lottery 5 more attractive (low RRP), thus the difference of their RRP should increase. This parameter therefore corresponds to γ in prospect theory (again with opposite direction). Contrary to γ in prospect theory, this parameter should be decoupled from risk aversion which can be seen as an additional advantage.

To test the reliability of this approach, Crombach's alpha has been computed for the first two scales, leading to values of 0.753 and 0.942, respectively. Taking out lottery 5 would increase the reliability of the first scale, but only marginally, so we decided to keep the original formulation.

As a second robustness test we checked the correlation of our RRP in gains with the two measures for "propensity to take risk" (in income and portfolio decisions, respectively) in the data of Statman (2008). The overall correlation coefficients were −0.546 and −0.565, both significant on the 95% level (with $N = 15$ countries in the intersection of both studies), demonstrating the reproducibility of the results and their robustness against changes of the survey methodology.

That the RRP approach is more stable than an estimation of the classical CPT parameters can be seen from the following considerations:

Consider the simple lottery that gives 0 with probability p and $y > 0$ with probability $1 - p$. Assume furthermore that subjects do i.i.d. mistakes e when stating their CE, then $RRP = (EV - (CE + e))/EV$. Thus, in the limit, the estimated RRP converge to the true average, since the error term is *linear*. Estimating the CPT-parameters, however, leads to a highly nonlinear contribution of the error e, e.g., we obtain (for simplicity neglecting probability weighting)

$$\alpha = \frac{\log(1-p)}{\log(y) - \log(CE + e)},$$

which is highly nonlinear and also very sensitive to errors, particularly when $CE + e$ comes close to 0 or y. Due to this nonlinearity, the estimated parameters will not converge to the true average in the limit.

In principle, we could convert the RRP values back to CPT parameters, however, as there is a strong interaction between probability weighting and risk preferences, this would give misleading results. As we will be mostly interested in cross-country differences, the precise scaling of our measurement is anyway of lesser importance than its reliability.

The estimated country averages for the three parameters can be found in Table 5. The result is not directly comparable to the prospect theory parameters from Table 2: instead of taking the median answers for each country and computing the parameters accordingly, the parameters have

Table 3: Component matrix for the factor analysis of the relative risk premia.

	Components		
	Factor 1 ("gains")	Factor 2 ("losses")	Factor 3 ("prob. weight.")
RRP lottery 1	0.827	0.199	-0.184
RRP lottery 2	0.865	0.247	0.033
RRP lottery 3	0.872	0.205	-0.132
RRP lottery 4	0.753	0.213	-0.149
RRP lottery 5	0.389	0.127	0.907
RRP lottery 6	0.84	0.186	-0.025
RRP lottery 7	-0.608	0.758	-0.029
RRP lottery 8	-0.615	0.753	-0.002

now been computed for each individual subject before taking the median for each country. Moreover, the scales are different: a high risk premium means more risk averse behavior, whereas for α the opposite is the case.

It should be mentioned that a number of countries that show (in the median) negative probability weighting. In fact, in these countries RRP was *lower* for lotteries with a small chance of losing then for lotteries with a small chance of winning. Given, that the expected value and also the CE were in these lotteries different, this effect could be attributed to different risk aversions and does not necessarily imply "negative" probability weighting.

Comparing the values with the CPT values, there are in particular some differences with respect to the risk attitudes in losses and probability weighting: in prospect theory risk attitudes are also influenced by the parameter γ, as the probability weighting function is in the standard formulation not symmetric. A small value of γ can therefore be induced by large risk aversion rather than by genuine overweighting of small probabilities. This can explain how the small amount of probability weighting that we measured can still lead to a small value of γ, and how, on the other hand, a substantial risk seeking behavior in losses (which we observe in more than 80% of the subjects) can still be modeled with a β that is close to one.

The second approach to stable parameters is based on a factor analysis of the eight RRP. When prescribing a three-factor model this leads to the factors presented in Table 3.

We see that the factor loading to some extent mimic the previous theoretically motivated definition: whereas the first factor corresponds to risk-aversion in gains, the second corresponds to the difference of risk attitudes in losses, and the third one to the difference of risk aversion in particular in lottery 5, the lottery with the small probability to win, that is similar to our previously defined probability weighting parameter. The median values of the three factors for the countries in our study are given in Table 5.

Choosing two factors, leads to a model representing only the first two dimensions (without probability weighting), while a fourth factor would reflect the difference in risk attitudes towards the high stake lottery 4. For consistency reasons we decided to use the three-factor model in the following analysis.

The correlation between the three RRP measurements on the one hand and the three factors on the other hand is high, as is shown in Table 4. We will therefore in the following mainly work with the RRP measurements and use the three factor model as robustness check. The three factors will be denoted as RRP factor “gains”, RRP factor “losses” and RRP factor “probability weighting”.

Table 4: Correlation between the three RRP measurements (upper row) and the three factor model (left column).

	RRP for gains	RRP for loss	RRP for ProbWeight
RRP Factor 1	**0.904*** **	-0.629***	-0.065***
RRP Factor 2	0.242***	**0.777*** **	-0.052***
RRP Factor 3	0.350***	-0.016	**-0.982*** **

To the three risk parameters that we have now defined (in two different ways), loss aversion, as measured by θ is added. Since the distribution of θ is highly skewed (skewness 6.77), even after eliminating outliers, we will work in the following with $\log \theta$.

4 Economics, culture and risk: empirical results

4.1 The role of economic conditions and cultural factors

In this section we study the relation between economic and cultural factors on the one side and risk preferences on the other side. The empirical findings about the relation between wealth and risk attitudes are mixed. Some find poor people are more risk-averse (Fafchamps & Pender 1997, Nielsen 2001); some find wealthier are more risk-averse (Wik & Holden 1998, Yesuf & Bluffstone 2008); others find little relationship between risk attitudes and wealth, e.g., Binswanger (1981) or Mosley & Verschoor (2005). Using the instrumental variable approach, Tanaka, Camerer & Nguyen (2010) suggest that risk aversion and impatience may lead to poverty.

Although studies on the influence of wealth and economic conditions on risk preferences, there has been in recent years also some evidence for the influence of cultural differences on risk preferences. – We have mentioned already in the introduction the work by Bontempo et al. (1997), Hsee & Weber (1999) and Wang & Fischbeck (2008). There is also recent work by Statman (2008) that suggests a possible influence of individuality (in the

Table 5: Measurements on relative risk premium parameters across countries.

	Relative risk premium (median of subjects' RRP)		
	RRP gains	RRP losses	RRP Probability Weighting
Angola	0.64	-0.29	0.06
Argentina	0.74	-0.33	0.00
Australia	0.65	-0.44	0.00
Austria	0.65	-0.38	-0.01
Azerbaijan	0.36	-0.29	0.22
Bosnia/Herzegovina	0.75	-0.61	0.19
Canada	0.77	-0.29	0.00
Chile	0.67	-0.17	0.00
China	0.56	-0.35	0.00
Colombia	0.87	-0.67	0.00
Croatia	0.76	-0.69	0.06
Czech Republic	0.65	-0.49	-0.01
Denmark	0.64	-0.17	-0.11
Estonia	0.91	-0.63	-0.01
Georgia	0.59	-0.17	0.61
Germany	0.80	-0.54	-0.02
Greece	0.66	-0.77	0.15
Hong Kong	0.93	-0.72	-0.02
Hungary	0.83	-0.54	-0.02
Ireland	0.86	-0.54	0.00
Israel	0.83	-0.63	-0.02
Italy	0.80	-0.35	0.06
Japan	0.76	-0.54	-0.01
Lebanon	0.94	-0.88	0.00
Lithuania	0.88	-0.67	0.07
Malaysia	0.64	-0.81	-0.06
Mexico	0.93	-0.72	0.00
Moldova	0.44	-0.32	0.27
New Zealand	0.67	-0.64	0.00
Nigeria	0.69	-0.60	0.15
Norway	0.75	-0.46	-0.02
Portugal	0.61	-0.29	0.00
Romania	0.62	-0.24	0.09
Russia	0.88	-0.73	0.00
Slovenia	0.83	-0.53	-0.06
South Korea	0.55	-0.39	-0.04
Spain	0.72	-0.23	-0.03
Sweden	0.65	-0.21	0.04
Switzerland	0.79	-0.46	-0.03
Taiwan	0.66	-0.54	0.00
Thailand	0.60	-0.52	-0.01
Turkey	0.63	-0.18	0.09
UK	0.72	-0.49	0.00
USA	0.78	-0.43	-0.01
Vietnam	0.67	-0.33	0.00

sense of Hofstede (1991)) on risk aversion.

A particularly interesting aspect is that differences between nationalities persist even under identical macroeconomic conditions, e.g., it has been shown in Bartke (2007) that there are significant differences in risk aversion among different nationalities of foreigners living in Germany that correspond, by the way, quite nicely to the differences that we measure in their respective home countries.[4]

However, most of these studies suffered from restrictions in data on risk preferences and could compare only a few countries that varied in more than one factor, making it difficult to reach clear conclusions about the importance of cultural differences in explaining risk preference variation.[5]

Based on this empirical evidence, a couple of theoretical models explaining differences in risk preferences have been suggested. The most prominent one is probably the already mentioned "cushion hypothesis" (Hsee & Weber 1999).

Our large-scale survey allows to take a closer empirical look at these hypotheses and the general question of whether cultural differences influence risk preferences in a statistically significant way.

4.2 Data selection

The large number of participants on our survey allows to discard subjects that gave inconsistent answers. We apply to conditions here which we will call "weak" and "strict consistency" in the following. In both conditions we exclude strong outliers regarding loss aversion, i.e. subjects with $\theta < 0.5$ or $\theta > 100$, leaving N=5158 subjects. Moreover, we exclude all subjects that violated in their answers to the lottery questions weak (respectively strong) in-betweenness. In other words, a certainty equivalence was only consistent if it was in-between the maximum and the minimum payoff of the respective lottery. In the case of weak consistency, it was admissible to choose the maximum or minimum payoff itself. In the case of strict consistency, this was excluded as well. Violation of in-betweenness suggests errors or misunderstandings of the survey question. Therefore it seems justified to exclude these subjects from the further analysis. The number of subjects satisfying weak and strict consistency for *all* lotteries is $N = 3541$ and $N = 2547$, respectively, and thus still large enough for our empirical analysis. In the

[4] Since there are only six nationalities in the data, it is not possible to obtain "hard" statistical evidence, but there is a strong positive correlation and the most risk averse country among them in our data (Turkey) was also the most risk averse in the data analyzed in Bartke (2007).

[5] The largest data sample on risk preferences so far has been collected by Statman (2008) and included 22 countries. The survey questions on risk, however, were more general, and the number of countries was still too small to apply rigorous statistical methods. All other cited studies investigated less than ten countries.

following we will mostly report results for strict consistent subjects, but robustness checks for weak consistency showed very similar results.

We measure risk attitudes by three parameters. For three of them we have the two aforementioned proxies: one based on the theoretical definition and one based on the three factor model for all eight RRP. The fourth measure is loss aversion ($\log \theta$). When using the RRP measures and loss aversion we apply WLS regressions to correct for heteroscedasticity where we use the inverse of the variance in each country as weights. Repeating the regressions with unweighted OLS did not lead to significant changes in the results.

A small proportion (around 10%) of our subjects was not studying economics or business administration. As robustness checks we have repeated the regressions without them which did not influence the results significantly. Similarly, we have checked whether students studying in a foreign country (also around 10% of our subjects) would affect the results, but we did not find significant deviation when omitting them.

As independent variables we use age, gender, log(GDP/capita), IDV and UAI, both as country average and as individual deviation from this average, and finally dummy variables for cultural regions (e.g. Anglo-American).

GDP/capita is used as a generic proxy for wealth of the subjects (which we could not measure on an individual level), but also for the overall development and stability of the country. It is not possible to disentangle these factors, as collinearity in our sample would be too high. We have, however, replaced GDP/capita with HDI (human development index) which did not change results significantly. The results were the same when adding more controls like inflation rate, financial development or measurements for macroeconomic or political stability, taken from the World Bank and from Porter & Schwab (2008). We therefore refrain from reporting these robustness checks.

Taking age into the regression is meant as a control, not as a mean to detect age dependency of risk attitudes, since the age distribution of our sample is (not surprisingly) very uneven (minimum 16 years, maximum 62 years, but only 0.67% older than 40 years). The gender distribution, however, was rather even (as mentioned above, 52% male, 48% female), thus significant coefficients in the regression results will indeed point to gender differences – at least in the subpopulation of undergraduates.

The assignment to cultural clusters was not based on the country the survey was taken, but on a survey question that asked specifically whether subjects felt to belong to some other culture than of their current place of living and if so, to state to which one. All in all 12% of the subjects chose this option. In this way we secured that students from a different ethnic background (exchange students or immigrants) were assigned correctly.

4.3 Within-country and cross-country variation

When studying cross-country variations it is important to check whether they are actually large enough to justify further investigation or whether they might be merely an artifact induced by substantial between-subject variation.

In our data we have both, and it is therefore essential to quantify both variations. To measure the average within-country variation, we computed therefore the standard deviations for the four main parameters in each country and took then the average. To measure, on the other hand, the cross-country variation, we computed the standard deviation of the country averages. Table 6 summarizes the results: cross-country variation is substantial, even though within-country variation (including noise!) is higher. Further investigation of cross-country differences is therefore promising.

Table 6: Cross-country variation in our sample is substantial (26%–53% of within-country variation).

	RRP gains	RRP losses	RRP prob.w.	$\log\theta$
Within-country variation	0.29	0.34	0.81	0.37
Cross-country variation	0.11	0.09	0.43	0.14
Ratio	38%	26%	53%	38%

4.4 Risk-aversion in gains

We start our empirical analysis with the risk attitude in gains (corresponding to α in prospect theory). Table 7 summarizes the regression results. (All regression results are – if not stated differently – OLS regressions and are reported with standardized coefficients and t-values in parentheses.) We see a significant and robust gender effect: female subjects tend to be more risk averse in gains which confirms previous studies (Agnew, Anderson, Gerlach & Szykman 2008, Borghans, Golsteyn, Heckman & Meijers 2009, Byrnes, Miller & Shafer 1999, Croson & Gneezy 2009, Hartog, Ferrer-i-Carbonell & Jonker 2002, Schubert, Gysler, Brown & Wolfgang Brachinger 1999).

There is also a significant effect of wealth: subjects from richer countries tended to be more risk averse. This supports previous studies by Wik & Holden (1998) and Yesuf & Bluffstone (2008), but contradicts results by Fafchamps & Pender (1997), Nielsen (2001), Binswanger (1981) and Mosley & Verschoor (2005).

We also find a strong and robust influence of culture as measured by Hofstede's Uncertainty Avoidance Index (UAI). As expected, a higher UAI lead to larger risk aversion.

Table 7: Regression results for the two proxies for risk preferences in gain lotteries.

	RRP for gain lotteries		RRP Factor "gains"	
	Model 1	Model 2	Model 1	Model 2
Age	-0.089***	-0.066***	-0.076***	-0.055***
	(-4.525)	(-3.331)	(-3.832)	(-2.769)
Gender	-0.187***	-0.163***	-0.2***	-0.186***
	(-9.456)	(-8.21)	(-10.044)	(-9.362)
log GDP/capita	0.113***	0.128***	0.074***	0.095***
	(5.71)	(6.281)	(3.73)	(4.629)
IDV, country average		-0.002		-0.021
		(-0.107)		(-0.974)
IDV, ind. difference		-0.017		-0.01
		(-0.849)		(-0.527)
UAI, country average		0.151***		0.132***
		(7.199)		(6.209)
UAI, ind. difference		0.05***		0.048**
		(2.569)		(2.412)
R^2 (%)	5.4	7.9	5	7.1

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

Although the data by Statman (2008) suggested a negative relationship, we did not find any significant impact of Individualism (IDV) on risk aversion in gains in our larger data sample.

4.5 Risk-seeking in losses

The regression results for risk preferences in losses (Table 8) deviated between the two dependent variables that we used as proxy. The only robust difference was that a larger country average for IDV led to a higher RRP in losses, i.e. reduced the extent of risk-seeking behavior.

This is compatible with the "cushion hypothesis" (Hsee & Weber 1999): in a less individualistic and more collectivistic surrounding it is possible for people to take more risk, as a potential loss will be mitigated by the social network (family, friends, community) surrounding the unlucky person and forming a kind of safety "cushion". It is interesting to see that the effect of the individual difference to the average IDV in a country was not a significant contributor to explaining risk attitudes in losses. The influence can therefore be seen as an effect of the surrounding rather than an effect of any personality trait of the person taking the risk. This again is nicely in line with the cushion hypothesis.

Table 8: Regression results for the two proxies for risk preferences in loss lotteries.

	RRP for loss lotteries		RRP Factor "loss"	
	Model 1	Model 2	Model 1	Model 2
Age	-0.006	-0.028	-0.065***	-0.076***
	(-0.308)	(-1.396)	(-3.227)	(-3.677)
Gender	0.123***	0.109***	-0.024	-0.023
	(6.077)	(5.353)	(-1.183)	(-1.106)
log GDP/capita	-0.009	-0.032	0.056***	0.039*
	(-0.456)	(-1.557)	(2.756)	(1.867)
IDV, country average		0.057**		0.062***
		(2.474)		(2.717)
IDV, ind. difference		0.003		-0.018
		(0.135)		(-0.87)
UAI, country average		-0.107***		-0.004
		(-4.851)		(-0.172)
UAI, ind. difference		-0.041**		-0.012
		(-2.049)		(-0.584)
R^2 (%)	1.5	3.5	0.8	1.2

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

Table 9: Regression results for the two proxies for probability weighting.

	RRP for Prob Weight			RRP Factor "Prob Weight"		
	Model 1	Model 2	Model3	Model 1	Model 2	Model3
Age	-0.039*	-0.035*	-0.036*	-0.009	-0.02	-0.016
	(-1.906)	(-1.646)	(-1.721)	(-0.427)	(-0.977)	(-0.781)
Gender	-0.065***	-0.074***	-0.07***	0.062***	0.059***	0.056***
	(-3.156)	(-3.533)	(-3.355)	(3.07)	(2.915)	(2.742)
log GDP/capita	-0.116***	-0.099***	-0.1***	0.159***	0.146***	0.149***
	(-5.704)	(-4.207)	(-4.209)	(7.897)	(6.966)	(7.1)
IDV, country av.		-0.06**	-0.061**		0.024	0.021
		(-2.505)	(-2.535)		(1.052)	(0.946)
IDV, ind. diff.		-0.003	-0.001		0.001	0.002
		(-0.155)	(-0.055)		(0.063)	(0.088)
UAI, country av.		-0.038*	-0.032		-0.063***	-0.077***
		(-1.645)	(-1.325)		(-2.918)	(-3.429)
UAI, ind. diff.		-0.022	-0.024		0.009	0.011
		(-1.067)	(-1.194)		(0.443)	(0.53)
Trust			0.004			-0.029
			(0.166)			(-1.405)
Empathy/Faith			0.045**			-0.057***
			(2.183)			(-2.807)
R^2 (%)	2.2	2.5	2.7	3.1	3.7	4.1

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

4.6 Probability weighting

In the case of probability weighting (and the following case of loss aversion), we augmented the regression model with two more variables: trust and self-responsibility. Trust has been measured as the level of agreement to the statement: "Most people can be trusted." Empathy/Faith has been measured as the level of disagreement to the statement: "When people have failed in life it is often their own fault."

When studying the regression results (Table 9), it is important to keep in mind that the the RRP in this case has the opposite direction of the RRP Factor (Pearson correlation is -0.982). Therefore we see that there are a number of robust relations:

We see a strong gender effect: female subjects show stronger probability weighting than males, similar to Fehr-Duda, De Gennaro & Schubert (2006). There is also a strong wealth effect: in wealthier countries, probability weighting is smaller. The cultural effects are less robust. The strongest effect can be found for empathy/faith: larger values correspond to larger probability weighting. A possible explanation would be that an overweighting of small probabilities does it seem likelier that a failure is caused by an unlikely strike of bad luck, rather than by a person's own faults.

4.7 Loss-aversion

For loss aversion as measured by $\log \theta$ we find a number of consistent effects (Table 10): first, there is a significant gender difference, in that female subjects showed a stronger loss aversion. There was also a strong influence of IDV: a larger country average of individuality corresponds to a smaller loss aversion, while individual differences point to the opposite direction. This is certainly a puzzling observation that is difficult to explain, in particular given the aforementioned cushion hypothesis.

The effect of UAI is again easy to interpret: larger levels of UAI correspond to larger loss aversion – on the country level, but also with respect to individual differences.

Finally, trust is reducing loss aversion. This can be interpreted in the way that less loss averse subjects are less afraid from potential abuse of their trust by other people.

4.8 Cultural clusters

Hofstede's cultural dimensions are a very successful tool for detecting cultural differences, but of course they cannot detect every cultural difference. It is therefore interesting to test whether there are (after controlling economic conditions, but also IDV and UAI) still significant differences in risk preferences between cultural clusters. We decompose our sample for this purpose into eight cultural clusters as in Wang, Rieger & Hens (2009):

Table 10: Regression results for the loss aversion $\log\theta$.

	Loss aversion ($\log\theta$)		
	Model 1	Model 2	Model3
Age	0.019	0.031**	0.034**
	(1.357)	(2.151)	(2.338)
Gender	-0.100***	-0.097***	-0.096***
	(-6.941)	(-6.722)	(-6.667)
log GDP/capita	-0.032**	-0.021	-0.019
	(-2.228)	(-1.419)	(-1.296)
IDV, country average		-0.045***	-0.049***
		(-3.024)	(-3.266)
IDV, ind. difference		0.028*	0.029**
		(1.93)	(1.999)
UAI, country average		0.044***	0.035**
		(2.947)	(2.249)
UAI, ind. difference		0.034**	0.034**
		(2.353)	(2.355)
Trust			-0.03**
			(-2.03)
Empathy/Faith			-0.016
			(-1.113)
R^2 (%)	1.1	1.8	1.9

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

Table 11: Percentage of subjects in each cultural cluster

Africa	Anglo/American	East Asia	East Europe
2.0%	8.8%	18.5%	22.9%
Germanic/Nordic	Latin America	Latin Europe	Middle East
21.9%	5.8%	4.1%	5.7%

Table 12: Regression results for the RRP of gain lotteries with additional dummy variables for cultural clusters.

	RRP for gain lotteries		RRP Factor "gains"	
	Model 1	Model 2	Model 1	Model 2
Age	-0.082***	-0.063***	-0.069***	-0.051**
	(-3.945)	(-3.02)	(-3.354)	(-2.447)
Gender	-0.188***	-0.169***	-0.193***	-0.185***
	(-9.419)	(-8.489)	(-9.674)	(-9.294)
log GDP/capita	0.138***	0.142***	0.112***	0.109***
	(5.65)	(5.839)	(4.543)	(4.449)
IDV, country average		-0.018		-0.048*
		(-0.678)		(-1.879)
IDV, ind. difference		-0.015		-0.01
		(-0.767)		(-0.527)
UAI, country average		0.147***		0.107***
		(6.567)		(4.519)
UAI, ind. difference		0.054***		0.05**
		(2.773)		(2.539)
cultural dummies:				
Africa	0.006	0.002	0.002	-0.015
	(0.302)	(0.112)	(0.097)	(-0.707)
Anglo-American	0.041	0.068**	0.008	0.032
	(1.431)	(2.358)	(0.272)	(1.074)
Germanic/ Nordic	0.086**	0.106***	0.012	0.047
	(2.193)	(2.628)	(0.319)	(1.175)
East Asia	0.029	0.053	-0.002	0.006
	(0.847)	(1.572)	(-0.059)	(0.164)
Latin America	0.119***	0.118***	0.079***	0.068***
	(4.644)	(4.569)	(3.194)	(2.711)
Latin Europe	0.036	0.009	0.022	-0.009
	(1.317)	(0.341)	(0.874)	(-0.355)
East Europe	0.123***	0.106***	0.122***	0.103***
	(3.555)	(2.996)	(3.509)	(2.868)
Middle East	0.061***	0.061**	0.06***	0.06**
	(2.581)	(2.537)	(2.573)	(2.548)
R^2 (%)	6.9	9.2	6.7	8.3

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

Table 13: Regression results for the RRP of loss lotteries with additional dummy variables for cultural clusters.

	RRP for loss lotteries		RRP Factor "loss"	
	Model 1	Model 2	Model 1	Model 2
Age	0.012	-0.008	-0.045**	-0.055***
	(0.549)	(-0.384)	(-2.104)	(-2.591)
Gender	0.118***	0.109***	-0.022	-0.021
	(5.763)	(5.335)	(-1.081)	(-1.044)
log GDP/capita	-0.062**	-0.067***	0.009	0.003
	(-2.471)	(-2.689)	(0.371)	(0.122)
IDV, country average		0.092***		0.079***
		(3.474)		(3.012)
IDV, ind. difference		0.001		-0.019
		(0.066)		(-0.935)
UAI, country average		-0.095***		-0.006
		(-3.877)		(-0.23)
UAI, ind. difference		-0.042**		-0.011
		(-2.095)		(-0.551)
cultural dummies:				
Africa	-0.011	0.008	-0.026	-0.017
	(-0.538)	(0.38)	(-1.215)	(-0.772)
Anglo-American	0.055*	0.03	0.068**	0.054*
	(1.838)	(0.995)	(2.187)	(1.725)
Germanic/ Nordic	0.096**	0.047	0.102**	0.072*
	(2.428)	(1.154)	(2.543)	(1.748)
East Asia	0.034	0.021	0.008	0.006
	(0.946)	(0.58)	(0.229)	(0.158)
Latin America	0.017	0.036	0.061**	0.077***
	(0.718)	(1.473)	(2.389)	(2.969)
Latin Europe	0.044*	0.086***	0.076***	0.089***
	(1.673)	(3.184)	(2.976)	(3.409)
East Europe	-0.021	-0.015	0.045	0.03
	(-0.613)	(-0.415)	(1.248)	(0.803)
Middle East	-0.036	-0.043*	0.018	0.007
	(-1.507)	(-1.782)	(0.729)	(0.272)
R^2 (%)	2.5	4.4	1.8	2.3

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

Table 14: Regression results for the probability weighting RRP with additional dummy variables for cultural clusters.

	RRP for Prob Weight		RRP Factor "Prob Weight"	
	Model 1	Model 2	Model 1	Model 2
Age	-0.032	-0.031	-0.005	-0.012
	(-1.546)	(-1.43)	(-0.23)	(-0.555)
Gender	-0.067***	-0.078***	0.058***	0.059***
	(-3.268)	(-3.731)	(2.933)	(2.94)
log GDP/capita	-0.14***	-0.14***	0.139***	0.137***
	(-5.388)	(-5.213)	(5.659)	(5.544)
IDV, country average		-0.11***		0.035
		(-3.854)		(1.37)
IDV, ind. difference		-0.002		0.000
		(-0.122)		(-0.017)
UAI, country average		-0.077***		-0.024
		(-3.059)		(-0.991)
UAI, ind. difference		-0.02		0.006
		(-0.992)		(0.295)
cultural dummies:				
Africa	0.001	0.004	-0.076***	-0.069***
	(0.054)	(0.192)	(-3.597)	(-3.217)
Anglo-American	-0.051	-0.046	0.106***	0.098***
	(-1.514)	(-1.363)	(3.537)	(3.225)
Germanic/ Nordic	-0.124***	-0.087*	0.209***	0.193***
	(-2.7)	(-1.854)	(5.368)	(4.842)
East Asia	-0.151***	-0.157***	0.263***	0.261***
	(-3.762)	(-3.888)	(7.437)	(7.379)
Latin America	-0.089***	-0.132***	0.118***	0.125***
	(-3.281)	(-4.572)	(4.77)	(4.981)
Latin Europe	0.023	0.018	0.046*	0.057**
	(0.935)	(0.732)	(1.878)	(2.254)
East Europe	-0.067*	-0.049	0.133***	0.133***
	(-1.92)	(-1.38)	(3.842)	(3.696)
Middle East	0.016	0.023	0.051**	0.048**
	(0.72)	(1.055)	(2.188)	(2.026)
R^2 (%)	3.6	4.4	7.3	7.5

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

Table 15: Regression results for $\log \theta$ with additional dummy variables for cultural clusters.

	Loss aversion ($\log \theta$)	
	Model 1	Model 2
Age	-0.012	-0.005
	(-0.552)	(-0.224)
Gender	-0.12***	-0.113***
	(-5.944)	(-5.596)
log GDP/capita	-0.043*	-0.06**
	(-1.689)	(-2.33)
IDV, country average		0.011
		(0.399)
IDV, ind. difference		0.009
		(0.44)
UAI, country average		0.093***
		(3.746)
UAI, ind. difference		0.043**
		(2.141)
cultural dummies:		
Africa	0.004	-0.001
	(0.204)	(-0.066)
Anglo-American	0.015	0.028
	(0.5)	(0.934)
Germanic/ Nordic	0.097**	0.117***
	(2.52)	(2.968)
East Asia	0.052	0.058*
	(1.493)	(1.666)
Latin America	0.054**	0.048**
	(2.265)	(1.983)
Latin Europe	0.049*	0.029
	(1.868)	(1.062)
East Europe	0.171***	0.146***
	(5.441)	(4.447)
Middle East	0.031	0.021
	(1.309)	(0.862)
R^2 (%)	4.1	4.9

* =significant on 10% level, **=significant on 5% level, ***=significant on 1% level

African countries, Anglo-American countries, Germanic/Nordic countries, East Asian countries, Latin America, Latin Europe, East Europe and Middle East. Subjects that stated other cultural regions (or did not specify their different cultural roots precisely) were categorized as "others" and form the benchmark of our regressions where we add dummy variables for the eight cultural clusters. Table 11 shows the distribution of the clusters in our sample.

The regressions results (Table 12–15) demonstrate that there is a substantial amount of cultural differences which is not covered by the cultural dimensions alone. This can be seen also in the increasing explanatory power (measured by R^2) as compared to the previous regressions.

The main effects that we have reported in the previous sections are robust under adding cultural cluster dummy variables. Additional interesting observations are the significantly larger risk aversion in gains for Latin and Eastern Europe and the Middle East, the reduced probability weighting in Germanic/Nordic, East Asian and Latin American countries, and the increased loss aversion in Germanic/Nordic, Latin America and in particular Eastern European countries.

4.9 Summary of the regression results

We summarize the (robust) results of the regressions from the last subsections in Table 16. We mention that in this table we have signed all variables in the most "natural" way, e.g. a "+" in the third column would mean that a person is more risk seeking in losses if the variable in the first column is larger. (Please note that in this case, this sign is opposite to the RRP in losses.) One could therefore say that all four risk variables in this table measure the amount of certain "biases" or, more precisely, the amount of deviation from risk neutrality.[6] A minus sign therefore implies that the variable in the first column has a mitigating effect on these biases, while a plus sign aggravates the bias. One interesting observation is that nearly all variables considered mitigate some biases, but aggravate others (or are only partially relevant).

4.10 Do cultural differences cause risk preferences to differ?

Our results so far suggest that there is a significant relation between differences of culture and risk preferences. Besides the obvious interpretation that culture forms preferences, it would be as conceivable that both are formed

[6] One could argue with Rabin (2000) that any substantial deviation from risk neutrality in small stake gambles points to behavioral biases: even if taking into account that some of our stakes were probably not small for the subjects, the large amount of risk aversion shown by many participants would allow to apply his argument.

independently by underlying factors (besides economic conditions) or that culture is indeed influenced by risk preferences.

To find support for a causal influence of culture on risk preferences, we apply an instrumental variable approach.[7] We use two variables that have already been used as instrumental variables for cultural dimensions: the distribution of blood types as a proxy for genetic and hence cultural distance, and the distribution of the main religions as a proxy for different cultural development in the past (Huang 2007, Spolaore & Wacziarg 2009, Guiso, Sapienza & Zingales 2009, Gorodnichenko & Roland 2010, Wang et al. 2009).

Table 16: Rough summary of the regression results for the four risk parameters. A bold face "+" denotes a robust positive influence, "(+)" denotes a mostly positive, but sometimes insignificant influence, "–" and "(–)" denote accordingly negative influences. The parameters are defined such that the deviation from risk neutrality increases when the parameter increase. Thus a minus sign points usually to a reduction of behavioral biases. Everything is valid only "ceteris paribus", i.e. controlling for other variables.

	Risk aversion in gains	Risk seeking in losses	Probability weighting	Loss aversion
Gender (male)	–	(–)	–	–
log(GDP/capita)	**+**	(+)	–	
IDV, country average		–	(–)	–
IDV, individual diff.				**+**
UAI, country average	**+**	(+)	(–)	**+**
UAI, individual diff.	**+**	(+)		**+**
Trust				–
Emapthy/Faith			**+**	
Africa				
Anglo/American		(–)		
Germanic/Nordic		(–)	–	**+**
East Asia			–	
Latin America	**+**		–	**+**
Latin Europe		–		
East Europe	**+**		(–)	**+**
Middle East	**+**			

The distribution of blood types has been measured based on the percentage of the population in a country having the blood types A, B, AB and O.[8] A good instrumental variable is given by the l^1-distance between the blood type vectors, which is the sum of the absolute differences for each of the

[7] We follow Wang et al. (2009) in several technical details.

[8] Values for Croatia, Slovenia, Taiwan and Chile were not available and replaced with the linguistically closest neighbors. Colombia and Mexico were excluded due to lack of data.

four types. The difference of two countries with respect to the distribution of the main religions has been measured as the Euclidean distance between the vectors reflecting the percentage of protestants, catholics, orthodoxes, muslims, buddhists, jews and others in the countries, where the category "others" was normalized such that the sum of all categories added to one.

In both cases, "difference" has to be measured with respect to a base country. Since in both IDV and UAI Sweden showed the most extreme values in our sample (highest individuality and lowest uncertainty avoidance), we chose this country as benchmark. Scatterplots and histograms of the two main instrumental variables and UAI and IDV (on the country level) can be found in Fig. 1.

As controls in our two-stage least-square regression we used age, gender and log(GDP/capita). As robustness checks we applied both instrumental variables together and separately and applied the Mahalanobis distance as alternative metric for both, blood types and religions.

As selection criterion for subjects we use the weak consistency. In the case of $\log\theta$ as dependent variable, we only use the usual restriction that $\theta \in [0.5, 100]$. UAI and IDV are, as usual, measured on the individual level. We do not take the country average into account in this case, in order to have only one predictor in every two-step least square regression.

We investigate causality for all cases where we have found strong and robust evidence for a relation between cultural dimensions and risk preferences in the previous sections: For lotteries in gains, we test the impact of UAI. For lotteries in losses and for loss aversion, we test the impact, both of UAI and IDV.

We conducted a number of robustness checks where we varied the measurement of the instrumental variables (using alternative distances, like the Mahalanobis metric and the l^{∞}- or supremum-metric), the number of control variables, or replaced the average RRP with the corresponding RRP factor variable. A few of these robustness checks can be found in the following regression tables, particular in the first of them (Table 17).

The instrumental variable analysis suggests in several instances a causal relation between cultural variables and risk preferences:

- For gain lotteries, a very robust and significant impact of UAI on risk aversion has been found (Table 17).
- For loss lotteries, there is a significant impact of UAI and IDV on risk aversion (Table 18), where UAI *increases*, while IDV *decreases* risk-seeking behavior. Again, the influence of IDV gives some support for the cushion hypothesis.
- The impact of UAI and IDV on loss aversion is mostly significant, but not strongly. Moreover, the result is not as robust: when choosing religion as instrumental variable, significance is usually lost. This might

point to a problem with this instrumental variable, e.g., to a a direct effect of religion on loss aversion which was supported in additional regression analyses: we added the proportion of the six main religions into the regression and found a *very strong* effect of the percentage of orthodox people in a country. The effect was stable when controlling for UAI, IDV and even for cultural clusters (compare Table 20).[9] This suggests that genetic distance (as proxied by the blood type distance) is the superior instrumental variable in this case.

Table 17: Results of the two-stage least square regression on RRP in gains.

Dependent var.:			RRP gain lotteries		Factor "Gains"
Instruments:					
Blood dist.	yes		yes		
– Mahalanobis				yes	yes
Religion dist.		yes	yes		
– Mahalanobis				yes	yes
Controls:					
Age	-0.033	-0.031	-0.032	-0.049*	-0.033
Gender	-0.072***	-0.069***	-0.070***	-0.080**	-0.079*
log(GDP/capita)	0.188***	0.188***	0.188***	0.161***	0.109***
Predictor:					
UAI	0.526***	0.572***	0.555***	0.842***	1.099***
t-value	(2.583)	(2.764)	(2.706)	(3.84)	(4.141)
Regression:					
F-value	33.8***	32.8***	33.2***	25.2***	21.4***
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

[9] In fact, no other risk parameter was influenced in such a robust and highly significant way by a religion than loss aversion was by orthodox christianity. An interesting point that suggests further inquiry.

Table 18: Results of the two-stage least square regression on RRP in losses.

Dependent var.:	RRP losses lotteries					
Instruments:						
Blood	yes		yes	yes		yes
Religion		yes	yes		yes	yes
Controls:						
Age	-.080***	-.078***	-.083***	-.084***	-.075***	-.077***
Gender	.103***	.103***	.104***	.023	.036	.033
log(GDP/capita)	-.063**	-.060*	-.069**	-.008	-.007	-.007
Predictor:						
IDV	.911***	.859***	.997***			
t-value	(2.899)	(2.580)	(3.227)			
UAI				-.807***	-.641***	-.678***
t-value				(-3.565)	(-3.007)	(-3.140)
Regression:						
F-value	7.2***	7.1***	7.3***	8.2***	8.1***	8.1***
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Table 19: Results of the two-stage least square regression on the $\log \theta$.

Dependent var.:	Loss aversion ($\log \theta$)					
Instruments:						
Blood	yes		yes	yes		yes
Religion		yes	yes		yes	yes
Controls:						
Age	.054***	.053***	.055***	.048***	.044***	.052***
Gender	-.087***	-.087***	-.087***	-.063***	-.069***	-.056***
log(GDP/capita)	-.032	-.033	-.030	-.054***	-.056***	-.052***
Predictor:						
IDV	-0.568*	-0.545	-0.614**			
t-value	(-1.657)	(-1.276)	(-2.441)			
UAI				0.348*	0.278	0.428**
t-value				(1.91)	(1.447)	(2.365)
Regression:						
F-value	12.8***	12.8***	13.2***	16.7***	16.9***	16.5***
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Table 20: Impact of religions (in particular orthodox christianity) on loss aversion.

	Model 1		Model 2		Model 3		Model 4	
	std.coeff.	t-value	std.coeff.	t-value	std.coeff.	t-value	std.coeff.	t-value
Age	-0.01	-0.56	-0.03	-1.29	-0.03	-1.33	-0.01	-0.50
Gender	-0.11***	-5.28	-0.11***	-5.30	-0.11***	-5.29	-0.11***	-5.25
log(GDP/capita)	-0.02	-0.87	-0.04	-1.45	-0.03	-1.07	-0.02	-0.93
IDV, country average	0.03	1.30	0.02	0.94	0.01	0.22	0.02	0.55
IDV, individual difference	0.01	0.30	0.00	0.09	0.00	0.06	0.01	0.34
UAI, country average	0.10***	4.78	0.14***	5.32	0.12***	4.14	0.10***	4.10
UAI, individual difference	0.04**	2.07	0.04**	2.01	0.04**	2.12	0.04**	2.09
Orthodox population	**0.14*** **	**6.54**	**0.17*** **	**5.45**	**0.14*** **	**4.16**	**0.13*** **	**5.29**
Catholic population			0.03	0.67	0.01	0.2		
Proptestant population			0.09*	1.93	0.05	1.01		
Muslim population			-0.02	-0.70	-0.03	-0.80		
Buddhist population			0.07*	1.68	0.12**	2.51		
Jewish population			0.04*	1.95	0.03	1.03		
Africa					0.01	0.25	0.00	-0.02
Anglo-American					0.04	1.42	0.02	0.79
Germanic/Nordic					0.13***	3.24	0.11***	2.78
East Asia					0.03	0.64	0.07**	2.07
Latin America					0.07**	2.48	0.06	2.29
Latin Europe					0.03	1.11	0.02	0.67
Eastern Europe					0.12***	3.28	0.09***	2.59
Middle East					0.05	1.14	0.03	1.05

5 Conclusion

We have presented results from the first large-scale international survey on risk preferences. Cultural differences do not prevent risk preferences to be *qualitatively* different, i.e. most people worldwide follow in their behavior the typical features that prospect theory captures: risk aversion in gains, risk seeking behavior in losses, overweighting of small probabilities and loss aversion. The *quantitative* differences, however, are large: not only on an individual level, but also on a between-countries level. These differences can be explained to some extent by economic, but also cultural differences. Using a regressions analysis and an instrumental variables approach, we found support for the hypothesis that cultural factors indeed cause substantial differences in risk preferences.

Our results might serve as an interesting starting point for further research in cultural economics. Moreover, future research should also relate our findings to international differences in market returns, as for example the cost of capital.

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A Instrumental variables

Figure 1 gives an overview of the two main instrumental variables, their correlations with the two main cultural dimensions and their distributions.

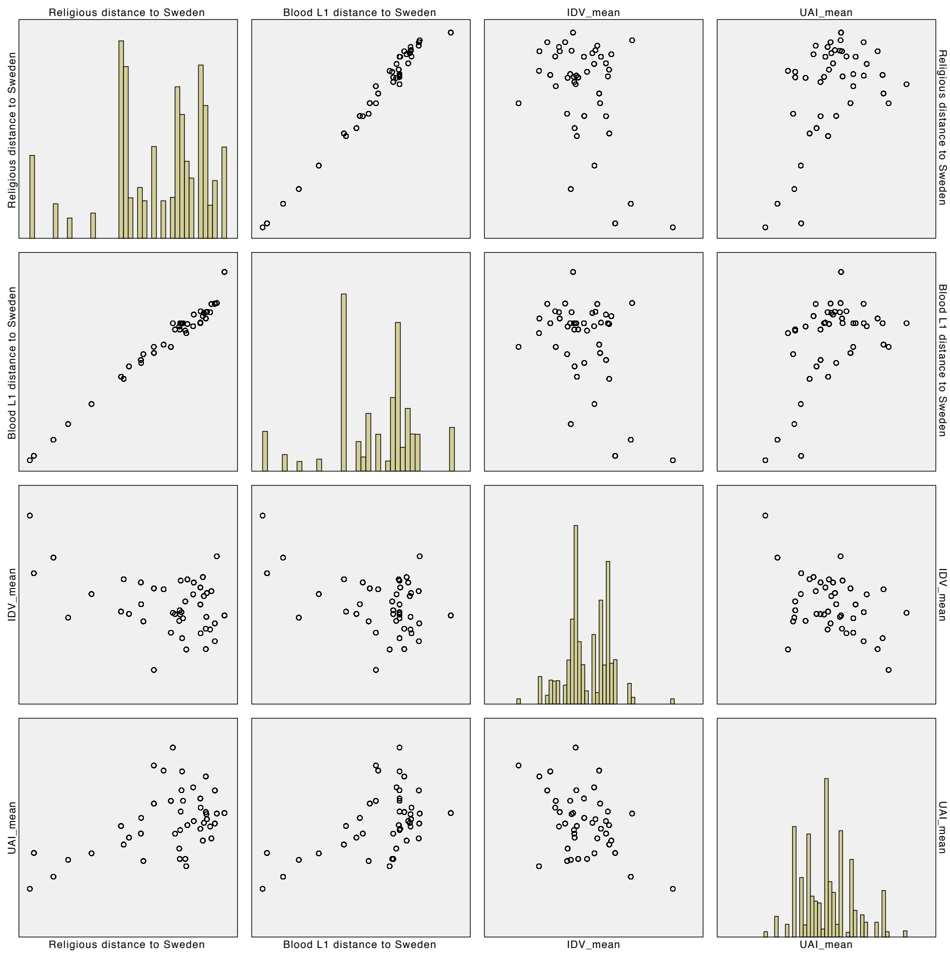

Figure 1: Scatterplot matrix for the two main instrumental variables (religious Euclidean distance and blood types l^1-distance), IDV and UAI on the country level.

B Universities participating in INTRA

The following universities participated in INTRA: Catholic University of Angola, Universidad Torcuato Di Tella (Argentina), Universität Innsbruck (Austria), Alpen-Adria-Universität Klagenfurt (Austria), University of Adelaide (Australia), Khazar University (Azerbaijan), University of Windsor

(Canada), University of British Columbia (Canada), Fudan University (China), Peking University (China), Renmin University (China), Universidad de Chile, Universidad de los Andes (Colombia), Buiseness College Vern' (Croatia), CERGE-EI (Czech Rep.), University of Southern Denmark, University of Copenhagen (Denmark), Tallinn University of Technology (Estonia), Universität Hamburg (Germany), Universität Trier (Germany), Universität Konstanz (Germany), Otto-von-Guericke Universität Magdeburg (Germany), University of Thessaly (Greece), Hong Kong Chinese University, Hong Kong Baptist University (Hong Kong), University of Pécs (Hungary), Ben Gurion University (Israel), NUI Maynooth (Ireland), Università degli Studi di Venezia (Italy), Foreign Trade University (Vietnam), Doshisha University (Japan), American University of Beirut (Lebanon), Vilnius University (Lithuania), University of Malaya (Malaysia), Universidad de Guanajuato (Mexico), MAES Kishinev (Moldova), Massey University (New Zealand), University of Ibadan (Nigeria), NHH Bergen (Norway), University of Lisboa (Portugal), Bucharest Academy of Economic Studies (Romania), Russian Customs Academy Vladivostok (Russia), University of Ljubljana (Slovenia), Seoul National University (South Korea), Universidad pablo de Olavide (Spain), University of Zurich (Switzerland), National Sun Yat-sen University (Taiwan), Chulalongkorn University (Thailand), Middle East Technical University (Turkey), Bogazici University (Turkey), Keele University (UK), Emory University (USA), Santa Clara University (USA), Princeton University (USA).