

# The Evolution of Risk Attitudes: A Panel Study of the University Years

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## Abstract

We exploit a unique longitudinal dataset of university students to study the stability of risk preferences over five years. We find that overall, subjects' risk tolerance measured by incentivized lottery choice increases over time, while decreases if measured by a self-assessed survey question. Moreover, we examine the impact of negative experiences and emotions on subjects' temporal change of risk preferences. We demonstrate that for the same group of respondents, the risk tolerance elicited by the incentivized measure is more robust while the survey measure is more sensitive in the face of negative shocks. Our findings contribute to a deeper understanding of how risk preferences evolve over time and underscore the significance of appropriate measurement methods when studying risk attitudes.

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# 1 Introduction

We use a longitudinal panel study to examine changes in the risk preferences of a cohort of undergraduate students over five years (2016-2021). Using two different measures, we elicit the students' risk preferences prior to matriculation and then multiple times through their undergraduate career and for more than a year post-graduation.

We are not the first to ask whether risk preferences are stable over time. However, our study follows a sample of individuals during a particularly formative period of their lives, allowing us insight into the development of long-term preferences. The study design also includes information concerning our subject's life experiences throughout their college and into their post-college career.

We focus on two distinct measures of risk attitudes: an incentivized lottery-choice task by [Dave, Eckel, Johnson, and Rojas \(2010\)](#), and a validated non-incentivized survey measure of self-reported willingness to take risk based on questions in the German Socio-Economic Panel (SOEP) ([T. Dohmen et al., 2011](#)). Subjects in the panel repeated these measures several times over the five-year period. The aggregate results show that subjects' willingness to take risks increases under the incentivized lottery-choice measure, but decreases when using survey measure.

This is curious and troubling, if we believe that all measures of risk aversion assess the same property of an individual's utility function. While several studies have documented instability of preferences across different measures (many here), others have argued that the SOEP survey measure has equal or superior validity as a measure of risk tolerance. Our study shows that the comparability of the measures cannot rest on a simple cross-sectional correlation, but that the two measures can exhibit different trends over time.

We also ask whether negative life experiences affect risk preferences over time. Our panel experienced the COVID-19 pandemic during their last semester of university. Our findings indicate that higher COVID-19 threats reduced risk tolerance as assessed by the survey measure, while the lottery-choice measure remains stable during the pandemic. We

also focus on impact of negative emotions during the pandemic on subjects' risk preferences. Our results indicate that the survey measure is more responsive to the effect of negative emotions, with sadness and fear reducing risk tolerance, and anger and hostility increasing risk tolerance. Consistent with the results from COVID-19 threats, the risk preference measured by lottery choice is less responsive to subjects' experience of negative emotions.

Our study provides insights into the stability of risk preferences in two ways. First, exploiting a unique panel dataset, we provide a direct comparison between two different risk elicitation measurements. We show that different risk-attitude measures provide distinct risk stability patterns, depending on whether the measurement is incentivized or survey-based. Secondly, we provide evidence on the impact of negative experiences on individual risk preferences, explaining the instability of risk attitudes over time and suggesting that the incentivized measure of risk attitude is more robust in the face of negative experiences, while the self-reported survey measure is more sensitive in capturing the impact of negative experiences on risk attitudes. These findings underscore the significance of using appropriate measures and considering external influences when studying risk attitudes over time.

## 2 Motivation

Numerous studies explore whether risk preferences are stable. The instability of risk preferences can be conceptualized in at least two different ways: in the long term, the risk preference is changing along with aging; in the short term, the risk preference is affected by life experiences. For the lifetime risk preference evolution, there has already been clear evidence that as individuals grow older, their willingness to take risks reduces ([T. Dohmen, Falk, Golsteyn, Huffman, & Sunde, 2017](#); [T. Dohmen et al., 2011](#); [Schildberg-Hörisch, 2018](#)). Moreover, there are also emerging studies showing how exogenous shocks affect risk preferences, lastingly or temporally. For example, [Meier \(2022\)](#) found that losing a parent or a child significantly reduces risk taking. [Bandyopadhyay, Begum, and Grossman \(2021\)](#) found

that in the 12-week window, both male and female subjects became more risk seeking which was affected by stress levels.

However, the comparison of different elicitation methods in measuring risk preference stability receives less attention so far. Previous studies on the comparison of different measurements of risk attitudes mostly focus on the ability of different measures in predicting risky behaviors, for example financial investment, career choice, and unhealthy behaviors (T. Dohmen et al., 2017). For the stability of risk preference, there are a few new studies in recent years, which shows that the measurement of risk preference matters in capturing the temporal instability of risk preferences. Zhang and Palma (2022) find that incentivized experiment measures of risk preference are more robust during the pandemic, while context-based survey measures indicated a reduced willingness to take risks during the pandemic, mainly driven by female subjects. Adema, Nikolka, Poutvaara, and Sunde (2022) find that during the pandemic, the willingness to take risks increased if measured by incentivized methods, but decreased if measured by self-reported survey questions. Notice that both studies estimated the impact of COVID-19 on risk preferences at an aggregated level.

### 3 Experimental Design and Procedures

Our data come from a panel study examining the evolution of preferences across the four years that a student is enrolled in a university and follows those same students for more than a year after graduation. Full details of the study are provided in the Supplemental Information, Section ?? Prior to matriculation a cohort, consisting of two-thirds of the entering class of 2020, was recruited into this study. That panel of students was recontacted at numerous points during their college career and participated in further studies. These studies examined a number of different social and economic preferences. In this paper we only focus on subjects' risk preferences. It is important to note that by the end of the last part of the study just over 60 percent of the subjects had dropped out (see Table 1. Much of

the attrition was due to difficulties in contacting subjects during the COVID-19 pandemic and the fact that subjects had graduated and did not respond to email solicitations. Not all subjects participated in every study - many moved in and out of studies. In the analysis reported below we focus on the 150 respondents who participated in every study.

Two types of measures are used to elicit subjects' risk preferences. The first is a lottery choice task which was originally developed by [Eckel and Grossman \(2002, 2008\)](#) and further developed by [Eckel, El-Gamal, and Wilson \(2009\)](#) and [Dave et al. \(2010\)](#), in which subjects are presented with a menu of six lotteries, all with equal probability of a high or low outcome. The outcomes are varied so that the lotteries increase in expected return and variance for lotteries 1-5, but only an increase in variance from 5-6. The first lottery gives the subject a \$10 payoff for sure, while the sixth lottery is the most risky with the highest variation in payoffs, returning \$0 and \$28 with equal probability. Subjects are asked to choose their most-preferred lottery and then actually play this lottery to determine their payoff. Their choices reveal their risk preferences. See Figure [B1](#), [B2](#), and [B3](#) in the Appendix [A](#) for instructions and decision-page screenshots for this task.<sup>1</sup>

The second measurement is the self-reported risk tolerance assessment as used in the German Socio-Economic Panel [T. Dohmen et al. \(2011\)](#), in which subjects report their desired level of risk on a scale of 0 to 10, with 0 representing the most risk averse, and 10 representing the most risk taking (see Figure [B4](#) in Appendix [A](#)). These measures differ in that the first is incentivized, while the second is not.

We repeated these two risk measurement tasks for the subjects from July 2016 to June 2021. Table [1](#) lists the timeline of the studies and which measures were included in each study wave. Additional information was collected about subjects over time (including demographic and attitudinal information).

In order to address potential concerns that the Class of 2020 may have been unique in

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<sup>1</sup>This measure is widely used in laboratory experiments, online experiments, and lab-in-the-field experiments. We have chosen this task due to its simplicity and its minimal demand for participants' numerical abilities. See [Dave et al. \(2010\)](#) for the discussion of the simplicity and external validity of this task, in comparison to the lottery choice task developed by [Holt and Laury \(2002\)](#).

Table 1: Study Contents and Timeline

	Lottery Choice	SOEP Survey	N. of Subjects
Wave 1 (July 2016)	✓	✓	553
Wave 2 (October 2017)	✓	✓	488
Wave 3 (March 2020)	✓	✓	404
Wave 4 (April 2020)	✓	✓	402
Wave 5 (July 2020)		✓	282
Wave 6 (October 2020)		✓	219
Wave 7 (June 2021)	✓	✓	221

<sup>1</sup> In total, 150 subjects participated in all 7 waves of studies;

<sup>3</sup> This table only contains a subset of the tasks from the larger panel study. “Lottery Choice” is the lottery-choice task from [Dave et al. \(2010\)](#). “SOEP Survey” is the risk survey question from the German Socio-Economic Panel.

some unforeseen manner, or that the behavior of subjects changed due to repeated exposure to measures, we include a smaller sample of subjects from the graduating Classes of 2021, 2022, and 2023 in some of the analysis below. As with the Class of 2020, these groups each were given the same study questions one month prior to matriculation. In addition we recruited the remaining students from the Class of 2020 who never participated in any of the studies to complete the same study questions as in the pre-matriculation wave just prior to graduating.<sup>2</sup>

## 4 Results

We code the variables of the two risk measures so that a higher value indicates stronger risk tolerance. Following previous practice ([T. Dohmen et al., 2017](#)), we standardize the two risk measures to have a mean of zero and a standard deviation of one using the full sample, making these two variables comparable to each other and comparable across different waves and cohorts of subjects. Therefore, unless explicitly noted otherwise, all subsequent analyses

<sup>2</sup>With the onset of COVID-19 additional funding was obtained allowing us to recruit more subjects. Therefore, those students (Classes of 2021, 2022, 2023, and the untouched subjects) were included in Waves 4 through 7.

pertaining to these two risk measures in this section are conducted using the standardized values. Moreover, we focus on the 150 subjects who participated in all of the seven waves of studies listed in the previous section.<sup>3</sup>

## 4.1 Descriptive Statistics: Subject Characteristics

Table 2 summarizes the demographic information for subjects. 56% of the subjects are female, and the majority of subjects are Asian (38%) and Caucasian (32.7%). In Figure 1, we plot the distribution of subjects' responses to the two risk measure tasks, divided by gender: the left panel is the distribution for the incentivized lottery choice task, and the right panel is for the SOEP risk survey question. Both panels are restricted to the 150 panelists who participated in all studies. For both measures, the distribution of risk tolerance among male subjects is more left-skewed than among female subjects, indicating that male subjects are more risk-tolerant than females. The distributions and gender differences of both panels are similar to the distributions of risk measures in previous studies (Dave et al., 2010; T. J. Dohmen et al., 2005).

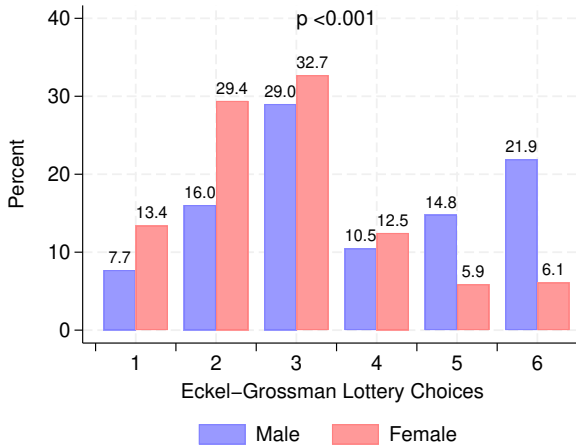
In Table 3 we examine the correlations between the lottery choice measure and the survey measure using Spearman's rank correlation coefficient, examining the associations within each gender and across different waves. The key finding from this table is that these two risk measures exhibit a moderate yet statistically significant correlation, suggesting a meaningful relationship between the incentivized lottery-choice task and the self-reported willingness to take risks as measured by the survey question.

## 4.2 Aggregate-Level Stability of Risk Attitudes Over Time

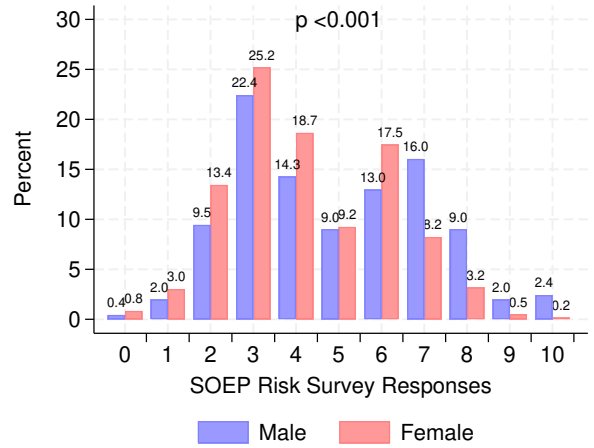
To what extent are risk preferences stable for the Class of 2020 panel? Figure 2 depicts the average of the standardized risk tolerance across all waves of studies conditional on gender.

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<sup>3</sup>See Table A1 in Appendix A for the comparison between those who are in the panel vs. those who dropped out. The comparison indicates that there are no systematic differences between these two samples.



(a) Lottery Choice



(b) SOEP Survey Measure

Figure 1: Distribution of Choices in Risk Measure Tasks

Note. Data in this table is restricted to the 150 panelists who participated in all studies. The risk attitudes in the left panel are measured by the lottery choice in Dave et al. (2010), and the risk attitudes in the right panel are measured by the SOEP survey question. Both panels report the distribution of unaltered task responses, without standardizing the value.  $p$ -values are from the Kolmogorov–Smirnov tests comparing the risk tolerance between men and women.

The left panel displays the average risk attitudes measured by the incentivized lottery choice task, and the right panel is based on the SOEP survey question. Notably, from month -1 to month 60, the left panel suggests an upward trend in risk tolerance, in contrast to a downward trend indicated by the right panel. This divergence in temporal changes between the two risk-elicitation methods suggests that the stability of risk preferences may depend on the methods employed for eliciting risk preferences.

To further validate the stability of risk preferences over time, Table 4 reports the panel regression of subjects’ risk tolerance, from one month before matriculation (July 2016) to one year after graduation (June 2021).<sup>4</sup> Columns (1) and (2) use the lottery choice from Eckel-Grossman as the dependent variable, while Columns (3) and (4) include the response to the SOEP survey on risk attitude as the dependent variable. In column (1), the coefficient associated with the variable “Months From Matriculation” is positive and significant ( $\beta =$

<sup>4</sup>In Table A5 in the Appendix we included the whole Class of 2020 for the same regression analysis as a robustness check, which returns similar results.



Table 2: Descriptive Statistics of the Panel of Class of 2020

%Female	56.7
%African American	2.7
%Asian	38.0
%Caucasian	32.7
%Hispanic/LatinX	12.0
%Other	4.0
%Foreign	8.7
%Unknown	2.0
Number of Subjects	150

<sup>1</sup> Data in this table is restricted to the 150 panelists from the Class of 2020 who participated in all studies.

Table 3: Spearmans' rho for Correlations between Lottery Choices and SOEP Survey Responses

	Spearman's rho	<i>p</i> -value
All	0.23	<0.001
Female	0.20	<0.001
Male	0.20	<0.001
Wave 1	0.15	0.073
Wave 2	0.24	0.004
Wave 3	0.34	<0.001
Wave 4	0.24	0.003
Wave 7	0.30	<0.001

<sup>1</sup> Data in this table is restricted to the 150 panelists from the Class of 2020 who participated in all studies.

.004). And the magnitude of this coefficient is robust after adding controls of race dummies in Column (2). Therefore, using the lottery choice as a measure of risk attitude, subjects are becoming .004 standard deviation more risk tolerant for each additional month. Extrapolated by a year, this magnitude leads to a .048 standard deviation increase in risk tolerance. In addition, the coefficient for the interaction between the Female indicator and the Months From Matriculation is negative but not significant, implying the absence of gender differences in the increasing trend of risk tolerance.

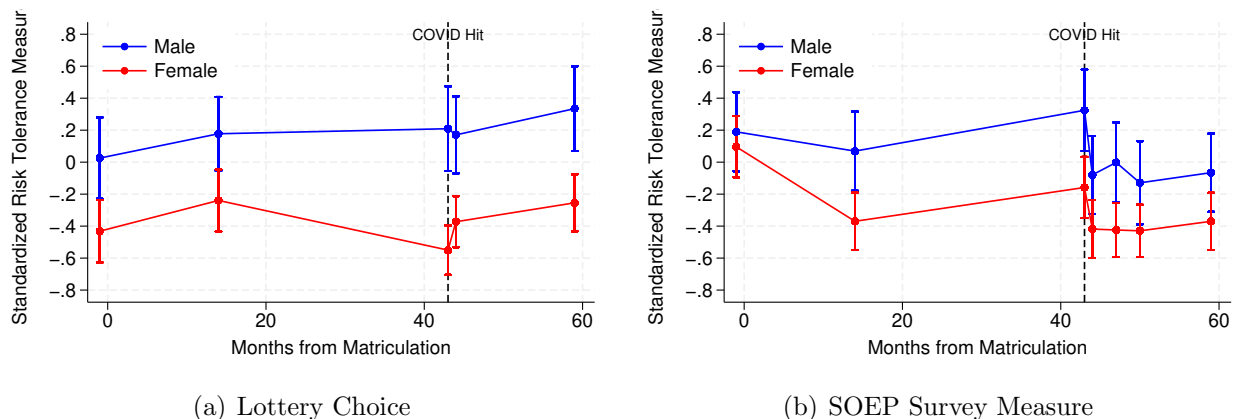


Figure 2: Average Risk Measures Across Time

Note. Data in this table is restricted to the 150 panelists who participated in all studies. The risk attitudes in the left panel are measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the risk attitudes in the right panel are measured by the SOEP survey question. Both risk measures are standardized to mean 0 and standard deviation 1 using the whole sample in all waves. Vertical bars indicate the confidence intervals of means. The vertical dash lines are the wave of study when Rice University locked down because of COVID-19 (March 2020).

By contrast, when we use the survey measure of risk attitudes (Column 3), the coefficient associated with the variable Months From Matriculation is negative and statistically significant ( $\beta = -.004$ ), i.e., extended over a year, the risk tolerance measured by the survey measure decreases by .048 standard deviation for an additional year post-matriculation. Notice that this effect size is higher than the impact of aging found in [T. Dohmen et al. \(2017\)](#) using the same survey measure, where an additional year of age decreased risk attitudes by about .021 standard deviation. One possible explanation of this difference could be the demographic differences between the two studies: our panel consists primarily of young university students, whereas the sample in [T. Dohmen et al. \(2017\)](#) encompasses a broader age range. This result suggests that students' risk tolerance, as self-reported in the survey, decreases over time, which contrasts with the findings obtained from the lottery-choice measure.

One possible confounding effect is the “participation effect”: subjects got used to these two risk-elicitation tasks through those repeated studies, and therefore we observe an increasing/decreasing trend for the lottery-choice task/SOEP survey response. In order to

Table 4: Panel Regression: Stability of Risk Preferences

	DV: Lottery Choice		DV: SOEP Survey Measure	
	(1) Eckel	(2) Eckel	(3) SOEP Risk	(4) SOEP Risk
Months From Matriculation	0.004* (0.002)	0.004* (0.002)	-0.004** (0.002)	-0.004** (0.002)
Female	-0.439*** (0.138)	-0.435*** (0.138)	-0.243* (0.145)	-0.258* (0.145)
Female $\times$ Months From Matriculation	-0.004 (0.003)	-0.004 (0.003)	-0.003 (0.002)	-0.003 (0.002)
Constant	0.059 (0.105)	-0.028 (0.173)	0.179 (0.116)	0.685* (0.363)
Observations	749	749	1050	1050
Individuals	150	150	150	150
Characteristics Controls	No	Yes	No	Yes

<sup>1</sup> Standard errors clustered at individual level are in parenthesis. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

<sup>2</sup> The dependent variables of Model (1) and (2) are the risk attitude measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the dependent variables of Model (3) and (4) are the risk attitude measured by the SOEP survey question. All variables are standardized to mean 1 and standard deviation 1 using the whole sample in all waves.

<sup>3</sup> Individual characteristics controls include race dummies.

deal with these potential confounds, we excluded a group of students from the Class of 2020 starting from the initial studies until Wave 3 when they became senior undergraduates. As described in Section 3, we call this group of students “untouched seniors”. Because this group of students never participated in any studies until Wave 3 in March 2020, we expect that if there exists a participation effect, their responses should be systematically different from the responses from the subjects who have participated in our studies before Wave 3. Therefore, in Table 5 we make comparisons of the risk measures between the untouched seniors with the Class of 2020. We also extract the 150 panelists from the Class of 2020 to make comparison with the untouched seniors. From this table, we do not see systematic differences in risk measures between subjects who have participation experiences and who do not. The only marginal exception emerged in the lottery choices, where the difference between the panelists and untouched seniors is marginally significant ( $p = .072$ ). However,

the average risk tolerance among the panelists is lower than that of the untouched seniors, contradicting any evidence of the participation effect causing the increasing trend in risk tolerance observed in Table 4. Therefore, we do not find evidence for participation effects as a reason for the increasing/decreasing trends of the two risk measures.

Table 5: t-test of 2020 Panel vs. Untouched 2020 Cohort in Wave 3

	Lottery Choices		SOEP Risk Measures	
	Mean	<i>t</i> -test with Untouched 2020 Cohort	Mean	<i>t</i> -test with Untouched 2020 Cohort
2020 Panelists	-.220	$p = .072$	0.050	$p = .343$
2020 All Respondents	-.109	$p = .340$	.055	$p = .229$
Untouched Seniors	-.030	–	0.151	–

<sup>1</sup> “2020 Panelists” contains 150 subjects who participated in all studies; “2020 All Respondents” contains the 404 subjects from the Class of 2020 who participated in Wave 3 (the 150 panelists are included as well); “Untouched Seniors” are 257 subjects who are also students from the Class of 2020 but were firstly introduced to our study, starting from Wave 3.

<sup>2</sup> *p*-values are from two-sample *t*-tests. For example, for the row of “2020 Panelists”, the *p*-value is from the *t*-test of the risk measure between the 2020 Panelists and the Untouched Seniors.

In addition, we also exclude the possibility that the special pattern from Table 4 is a cohort-specific pattern that only happened among the Class of 2020. In Appendix A, we compare the Class of 2020 with the Class of 2021, 2022, and 2023 when they were one month before matriculation (see Table A2 and A3), and we find that with the lottery choice measure, the Class of 2021 is significantly more risk tolerant than other entering classes, while with the SOEP survey measure, the Class of 2023 is more risk seeking than the other entering classes. However, we do not find evidence that the Class of 2020 was systematically different from all other entering classes. Moreover, we compare the Class of 2020 with the Class of 2017 when they were seniors. The results from Table A4 in the Appendix show no difference between these two cohorts in their fourth year regarding their two risk attitude measures. Therefore, we argue that the increasing pattern of risk attitudes measured by lottery choice and the decreasing pattern of risk attitudes measured by SOEP survey response are less

likely to be cohort-specific patterns.

**Result 1.** *During the 5 years from before matriculation to after graduation, subjects' risk tolerance measured by the incentivized lottery choices was increasing over time, but the risk tolerance measured by the un-incentivized survey measure was decreasing over time.*

### 4.3 Individual Instability: the COVID-19 Pandemic Threat

In this subsection, we examine individual experiences to identify potential explanations for the contrasting risk-tolerance trends we observed between our two measures. First, we focus on the impact of the COVID-19 pandemic on subjects' risk attitudes. On March 13, 2020, the Trump Administration declared the pandemic a nationwide emergency. Rice University cancelled its classes for the week of March 9, 2020, a week prior to spring break. On March 12, 2020, Rice announced that the university would transition to remote teaching and all undergraduate students were asked to leave campus by March 25, 2020. Our wave 3 study was launched on March 17, 2020. Consequently subjects at this point were participating in a period of high uncertainty. At the time little was known about COVID-19. It is quite likely that wave 3 represents an inflection point for our participants and we might expect that risk preferences abruptly changed at this time.

For each subject, across waves 3 through 7, we measure threats from COVID-19 using the 7-day change in county-wide positivity rates given the subject's location on the day of study participation. Starting from Wave 4, we used each subject's IP address derived from Qualtrics and retrieved their county locations. COVID-19 positivity rates are taken from data reported by the Center for Systems Science and Engineering (CSSE) at the Johns Hopkins University (JHU) (Dong, Du, & Gardner, 2020). The 7-day percentage point increase in positivity rate in each subject's county is used as a proxy for the threats from COVID-19.

Wave 3 did not collect subjects' IP addresses. Consequently, we adopt an alternative method to identify a subject's location. In that wave we asked subjects whether they were currently at home (75.7 percent), at the university (15.1 percent), or somewhere else (9.2

percent). For those who responded that they were at home, we used their home zip codes derived from administrative data. For those still on campus, we used the COVID-19 cases data in the Harris County in Texas. It is important to acknowledge that some zip codes may be associated with multiple county FIPS codes. For those home zip codes, we calculated the average of the 7-day percentage point increase across all associated counties, serving as the best approximation for the pandemic threats for those specific subjects.<sup>5</sup>

Table 6 reports the panel regression examining the impact of COVID-19 shocks on each individual’s risk preferences.<sup>6</sup> Columns (1) through (3) include subjects’ Eckel-Grossman lottery choices as the dependent variable, while Columns (4) through (6) involve the SOEP survey measure as the dependent variable. In Column (1) and (4) we run a basic regression, only including months from matriculation, whether the subject was female, the interaction of months and gender, and the 7-day percentage point increase in positivity rate (“7-D pp INC” thereafter). In Columns (2) and (5) we further include the interaction of the female indicator and the 7-D pp INC. And in Columns (3) and (6) we control for subjects’ race dummies.

In Columns (1) through (3), the coefficient associated with the variable “Months From Matriculation” is not statically significant, although the effect size, .003, is similar to what we find in Table 4. The coefficient associated with the *Positivity Rate* is positive, but not significant. Therefore, we do not find supporting evidence that the COVID-19 threat has an impact on subjects’ risk tolerance measured by lottery choice. Conversely, when using the SOEP survey measure (Columns (4) through (6)), the *Positivity Rate* coefficient is negative and statistically significant, indicating that for every percentage point increase in the positive case in the past 7 days, subjects’ risk tolerance decreases by around .4 standard deviations. The interaction between the *Positivity Rate* and being female is not statistically significant. This implies that there are no gender differences in the impact of pandemic threats on risk

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<sup>5</sup>For Wave 1 and 2, the 7-day percentage point increase in positivity rate is coded as 0 for all subjects.

<sup>6</sup>In Table A6 in the Appendix we included the whole Class of 2020 for the same regression analysis as a robustness check, which returns similar results.

preferences elicited by the SOEP survey measure. To validate the robustness of the findings above, we also use the 30-day percentage-point increase of positivity rates as the measure of COVID-19 threats, which returns similar findings, as shown in Table A7 in Appendix A.

The findings above are consistent with the findings from Zhang and Palma (2022) who find that incentivized risk measures are stable during the pandemic. They also show that the context-based surveys (e.g., Domain Specific Risk Taking by Blais and Weber (2006) and the Sensation Seeking Scale by Zuckerman, Kolin, Price, and Zoob (1964)) are more likely to be affected by the COVID-19. We extend their findings by including an unincentivized survey measure, i.e., the SOEP risk survey, into our study. Although the SOEP survey question does not include any concrete context, the risk attitude measured by it is still affected by the threats from the pandemic.

**Result 2.** *The pandemic severity has a negative impact on the risk tolerance measured by the SOEP survey measure, but does not affect the risk attitude measured by the incentivized lottery choice.*

#### 4.4 Individual Instability: Experience of Negative Emotions

We also ask whether negative emotions affect risk preferences. The sudden onset of the pandemic and changes associated with the pandemic may have triggered emotional responses by subjects. Previous studies have shown that negative emotions can change people’s risk preference (Eckel et al., 2009; Kamstra, Kramer, & Levi, 2003; Meier, 2022). In Waves 4 through 7, we collected subjects’ frequency of experiencing 11 negative emotion items (see Figure B5 for the screenshot of questions), such as feelings of loneliness, anger, and more. For each survey wave, we used confirmatory factor analysis with a varimax rotation for the ten emotion items. We expected two things. First, we are sensitive to the possibility that emotions shifted over time with the severity of COVID-19 and other life experiences. Second, we anticipated two distinct factors pertaining to low and high valence. Indeed, across these four waves, two distinct factors consistently emerge. The first factor, henceforth referred to

Table 6: Panel Regressions: Impact of COVID-19 Positive Cases on Risk Attitudes

	DV: Lottery Choice			DV: SOEP Survey Measure		
	(1)	(2)	(3)	(4)	(5)	(6)
Months From Matriculation	0.003 (0.002)	0.003 (0.002)	0.003 (0.003)	-0.003* (0.002)	-0.003 (0.002)	-0.003 (0.002)
Female	-0.440*** (0.138)	-0.440*** (0.138)	-0.436*** (0.138)	-0.239* (0.145)	-0.239* (0.145)	-0.251* (0.145)
Female $\times$ Months From Matriculation	-0.004 (0.003)	-0.003 (0.003)	-0.004 (0.003)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)
7-D pp INC in Positivity Rate	1.116 (0.797)	1.290 (0.887)	1.261 (0.901)	-0.393** (0.157)	-0.461** (0.219)	-0.459** (0.219)
Female $\times$ 7-D pp INC in Positivity Rate		-0.410 (1.688)	-0.389 (1.699)		0.136 (0.314)	0.126 (0.315)
Constant	0.063 (0.106)	0.064 (0.106)	-0.031 (0.174)	0.177 (0.115)	0.177 (0.115)	0.682* (0.363)
Observations	738	738	738	1028	1028	1028
Individuals	150	150	150	150	150	150
Characteristics Controls	No	No	Yes	No	No	Yes

<sup>1</sup> Standard errors clustered at individual level are in parenthesis. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

<sup>2</sup> The dependent variables of Model (1) and (2) are the risk attitude measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the dependent variables of Model (3) and (4) are the risk attitude measured by the SOEP survey question. All variables are standardized to mean 1 and standard deviation 1.

<sup>3</sup> Individual characteristics controls include race dummies.

as “Sadness and Fear”, is loaded on items capturing feelings related to sadness and fear. The second factor, designated as “Anger and Hostility”, demonstrated strong loadings for items associated with anger and hostility. We then calculate factor scores for each dimension and use these in our analysis.

Table 7 presents the panel regression results, with the lottery choice as the dependent variable in Columns (1) and (2), and the SOEP survey measure as the dependent variable in Columns (3) and (4). We include the two factor scores, “Sadness and Fear” and “Anger and Hostility,” from the factor analysis of the negative emotion items. Additionally, we introduce interactions between each factor score and the female indicator to assess gender differences in the impact of negative emotions on risk attitudes. In Columns (1) and (2), the coefficients associated with “Sadness and Fear” and “Anger and Hostility” are not statistically significant, suggesting a lack of evidence that higher frequencies of negative feelings significantly



affect subjects' risk attitudes as measured by lottery choices.

Conversely, in Column (3), we observe a statistically significant negative association between the "Sadness and Fear" score and risk tolerance measured by the SOEP survey ( $\beta = -.223$ ). And this estimate is robust after controlling for subjects' races in Column (4). Meanwhile, the "Anger and Hostility" score exhibits a statistically significant positive relationship with risk tolerance ( $\beta = .107$ ), although remains only marginally significant after adding individual controls in Column (4). These findings indicate that a higher frequency of experiencing sad and fearful feelings makes subjects less risk tolerant, while frequent experiences with anger and hostile feelings lead to some increase in subjects' risk tolerance. These findings align with [Meier \(2022\)](#), indicating that sadness leads to reduced risk tolerance, while anger leads to increased risk tolerance, with risk tolerance measured by the SOEP survey question. Furthermore, in [Table A8](#) in the Appendix we conduct a robustness check by including the whole Class of 2020 in the same regression analysis as in [Table 7](#). We still find a statistically significant negative effect of Sadness and Fear on risk tolerance, while the positive effect of Anger and Hostility on risk tolerance loses statistical significance. Therefore, the negative impact of Sadness and Fear on the risk attitude measured by survey questions is more robust in our sample.

Therefore, we find a contrasting effect of negative emotions on the risk attitudes measured by incentivized lottery choice tasks and by survey questions: while the incentivized lottery choices appear robust in the face of negative emotional shocks, the responses in risk survey questions are more sensitive to such influences. This finding emphasizes the importance of utilizing different measurements of risk attitudes when exploring the impact of negative emotions on risk preferences.

Moreover, we examine the gender differences in the impact of negative emotions on risk attitudes and we find only limited evidence. The interaction between "Sadness and Fear" and the female indicator is positive but not statistically significant ( $\beta = .142$  in Column (4)), indicating limited evidence of gender differences in the negative impact of sadness and fear on

risk tolerance. Furthermore, the interaction between "Anger and Hostility" and the female indicator is marginally significant and negative ( $\beta = -.117$  in Column 4), which reduces the positive effect of anger and hostility on risk tolerance. This finding provides some evidence that female subjects' risk attitudes seem to be less affected by anger and hostile feelings.<sup>7</sup>

Table 7: Panel Regressions: Impact of Negative Emotion on Risk Tolerance

	DV: Lottery Choice		DV: SOEP Survey Measure	
	(1)	(2)	(3)	(4)
Female	-0.539*** (0.132)	-0.517*** (0.132)	-0.277** (0.136)	-0.297** (0.135)
Sadness and Fear	-0.093 (0.087)	-0.124 (0.085)	-0.223*** (0.071)	-0.216*** (0.073)
Female $\times$ Sadness and Fear	0.068 (0.108)	0.100 (0.106)	0.151* (0.086)	0.142 (0.087)
Anger and Hostility	-0.003 (0.115)	-0.015 (0.127)	0.107** (0.054)	0.107* (0.055)
Female $\times$ Anger and Hostility	-0.063 (0.152)	-0.029 (0.160)	-0.113 (0.070)	-0.117* (0.070)
Constant	0.222* (0.115)	0.154 (0.204)	-0.133 (0.113)	0.351 (0.365)
Observations	300	300	600	600
Individuals	150	150	150	150
Characteristics Controls	No	Yes	No	Yes

<sup>1</sup> Standard errors clustered at individual level are in parenthesis. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

<sup>2</sup> The dependent variables of Model (1) and (2) are the risk attitude measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the dependent variables of Model (3) and (4) are the risk attitude measured by the SOEP survey question. All variables are standardized to mean 1 and standard deviation 1.

<sup>3</sup> The variables "Sadness and Fear" and "Anger and Hostility" are the two factor scores from the factor analysis over subjects' responses to the questions on frequencies of 10 different negative emotions.

<sup>4</sup> Model (1) and (2) includes data from Waves 4 and 7, because we did not include the lottery choice task in Waves 5 or 6. Model (3) and (4) includes data from Waves 4, 5, 6, and 7, as we collected the SOEP survey risk measure for all these waves.

<sup>5</sup> Individual characteristics controls include race dummies.

**Result 3.** *Risk attitude measured by incentivized lottery choices is stable in face of nega-*

<sup>7</sup>In Table A8 in the Appendix, we do not find robust results supporting the gender differences in the impact of negative emotions on risk attitudes.

*tive emotions, while the risk attitude measured by the un-incentivized SOEP survey measure is responsive to negative emotions, with sadness and fear significantly lowering risk tolerance, and anger and hostility leading to some increase in risk tolerance. Moreover, we observe limited evidence of gender differences in the impact of negative emotions on risk preferences.*

## 5 Conclusion

In this study, we investigated the risk preferences of undergraduate students over a five-year period, from before matriculation to one year after graduation. We utilized two distinct methods, the Eckel-Grossman lottery task and the German Socio-Economic Panel (SOEP) survey question, to measure subjects' risk attitudes. Our research aimed to compare the stability of risk preferences based on these measures at the aggregate level and to explore the impact of negative experiences on individual risk attitudes.

Our findings show that subjects' risk tolerance is increasing over time if measured by the incentivized lottery choice task, and is decreasing over time if measured by the SOEP survey measure. We also exclude alternative explanations of the participation effect and cohort-specific effect in shaping these two distinct risk evolution patterns. Furthermore, we highlighted the impact of exogenous shocks, such as the COVID-19 pandemic, on risk preferences, demonstrating how negative life experiences or sentiments can lead to shifts in risk tolerance at an individual level.

A significant contribution of this paper lies in the comparison of different risk elicitation methods in studying the stability of risk preferences. Our results not only exhibit differentiated trends of risk preferences measured by different risk elicitation measures, but also reveal that incentivized measures, like the lottery-choice task, exhibit more robust stability during challenging times, such as the pandemic, while context-based survey measures, like the SOEP questionnaire, are more sensitive capturing the impact of negative life experiences or emotions on subjects' temporal change in risk preferences. This highlights the importance

of the selection of measurement methods when studying the evolution of risk attitudes.

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**Electronic Supplementary Material of**  
The Evolution of Risk Attitudes: A Panel Study of the  
University Years

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**A Additional Analysis**

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Table A1: Balance Tests of Incoming Freshmen: Those in Panel vs. Those Dropping Out

	Panel Mean (SD)	Attrition Mean (SD)	<i>p</i> -value
Class of 2020			
Lottery Choice	-.234 (.080)	-.125 (.051)	.265
SOEP Survey	.137 (.076)	.218 (.045)	.357
N	150	403	
Class of 2021			
Lottery Choice	-.066 (.172)	.213 (.101)	.101
SOEP Survey	-.201 (.161)	.406 (.102)	.003
N	29	90	
Class of 2022			
Lottery Choice	-.068 (.167)	-.136 (.088)	.704
SOEP Survey	.260 (.165)	.135 (.083)	.462
N	41	111	
Class of 2023			
Lottery Choice	.086 (.145)	-.066 (.097)	.401
SOEP Survey	.329 (.156)	.446 (.095)	.524
N	39	104	
Untouched Seniors			
Lottery Choice	.098 (.132)	-.062 (.077)	.307
SOEP Survey	.250 (.135)	.121 (.076)	.408
N	61	196	

<sup>1</sup> “Panel” indicates those subjects who participated in all waves of studies, i.e., those that are in the balanced panel; “Attrition” indicates those subjects who dropped out at some point among those studies;

<sup>2</sup> “Untouched Seniors” are a group of students from the Class of 2020 who were excluded from the studies until Wave 3 when they already became senior graduates;

<sup>3</sup> Both the lottery-choice measures and SOEP survey measures are standardized into mean 0 and standard deviation 1 using the data from the whole sample;

<sup>4</sup> *p*-values are from two-tailed *t*-tests between the “Panel” group and the “Attrition” group.

Table A2: t-test of Eckel-Grossman before matriculation: t-score

	Class of 2020	Class of 2021	Class of 2022
Class of 2021	2.906***		
Class of 2022	-.367	2.237**	
Class of 2023	-1.371	1.388	-.857

<sup>1</sup> This table reports *t*-statistics from *t*-tests;

<sup>2</sup> \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

Table A3: t-test of SOEP risk before matriculation: t-score

	Class of 2020	Class of 2021	Class of 2022
Class of 2021	-.671		
Class of 2022	.316	.775	
Class of 2023	-2.499**	1.285	-2.219**

<sup>1</sup> This table reports *t*-statistics from *t*-tests;

<sup>2</sup> \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

Table A4: t-test of 2020 Panel in 2020 Spring vs. Class of 2017 in 2016 Fall

	Eckel-Grossman		SOEP Risk Measure	
	Mean	<i>p</i> -value	Mean	<i>p</i> -value
2020 Panel	-0.221	.068	0.051	.484
Class of 2017	0.005		0.138	

<sup>1</sup> “2020 Panel” indicates those subjects from the Class of 2020 who participated in all waves of studies, i.e., those that are in the balanced panel.



Table A5: Panel Regression: Stability of Risk Preferences (Unbalanced Class of 2020)

	DV: Lottery Choice		DV: SOEP Survey Measure	
	(1) Eckel	(2) Eckel	(3) SOEP Risk	(4) SOEP Risk
Months From Matriculation	0.005*** (0.001)	0.005*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)
Female	-0.345*** (0.076)	-0.350*** (0.076)	-0.193** (0.075)	-0.184** (0.075)
Female $\times$ Months From Matriculation	-0.005*** (0.002)	-0.005*** (0.002)	-0.002 (0.002)	-0.002 (0.002)
Constant	0.094* (0.056)	0.032 (0.117)	0.220*** (0.055)	0.182 (0.145)
Observations	2067	2067	2573	2573
Individuals	553	553	553	553
Characteristics Controls	No	Yes	No	Yes

<sup>1</sup> This table includes all participants from the Class of 2020, which is an unbalanced panel;

<sup>2</sup> Standard errors clustered at individual level are in parenthesis. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

<sup>3</sup> The dependent variables of Model (1) and (2) are the risk attitude measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the dependent variables of Model (3) and (4) are the risk attitude measured by the SOEP survey question. All variables are standardized to mean 1 and standard deviation 1 using the whole sample in all waves.

<sup>4</sup> Individual characteristics controls include race dummies.

Table A6: Panel Regressions: Impact of COVID-19 Positive Cases on Risk Attitudes (Unbalanced Class of 2020)

	DV: Lottery Choice			DV: SOEP Survey Measure		
	(1)	(2)	(3)	(4)	(5)	(6)
Months From Matriculation	0.008 (0.006)	0.008 (0.006)	0.008 (0.006)	-0.008 (0.005)	-0.008 (0.005)	-0.008 (0.005)
Female	-0.791** (0.353)	-0.846** (0.357)	-0.818** (0.358)	-0.380 (0.300)	-0.374 (0.302)	-0.359 (0.303)
Female $\times$ Months From Matriculation	0.004 (0.007)	0.004 (0.007)	0.003 (0.007)	0.002 (0.006)	0.002 (0.006)	0.002 (0.006)
cases_rate_increase7	0.631 (0.728)	0.023 (0.760)	-0.117 (0.740)	-0.503*** (0.140)	-0.455** (0.188)	-0.461** (0.187)
Female $\times$ cases_rate_increase7		2.200 (1.440)	2.193 (1.437)		-0.096 (0.282)	-0.098 (0.282)
Constant	-0.056 (0.274)	-0.032 (0.274)	0.047 (0.302)	0.413* (0.222)	0.410* (0.224)	0.576** (0.269)
Observations	970	970	970	1449	1449	1449
Individuals	441	441	441	448	448	448
Characteristics Controls	No	No	Yes	No	No	Yes

<sup>1</sup> This table includes all participants from the Class of 2020, which is an unbalanced panel;

<sup>2</sup> Standard errors clustered at individual level are in parenthesis. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ ;

<sup>3</sup> The dependent variables of Model (1) and (2) are the risk attitude measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the dependent variables of Model (3) and (4) are the risk attitude measured by the SOEP survey question. All variables are standardized to mean 1 and standard deviation 1;

<sup>4</sup> Individual characteristics controls include race dummies.

Table A7: Panel Regressions: Impact of COVID-19 Positive Cases on Risk Attitudes

	DV: Lottery Choice			DV: SOEP Survey Measure		
	(1) Eckel	(2) Eckel	(3) Eckel	(4) SOEP Risk	(5) SOEP Risk	(6) SOEP Risk
Months From Matriculation	0.004 (0.002)	0.004 (0.003)	0.004 (0.003)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)
Female	-0.441*** (0.138)	-0.437*** (0.138)	-0.436*** (0.138)	-0.237 (0.145)	-0.236 (0.145)	-0.250* (0.145)
Female $\times$ Months From Matriculation	-0.004 (0.003)	-0.004 (0.003)	-0.004 (0.003)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)
30-D pp INC in Positive Rate	0.112 (0.302)	0.035 (0.348)	0.025 (0.350)	-0.154*** (0.050)	-0.177** (0.076)	-0.177** (0.077)
Female $\times$ 30-D pp INC in Positive Rate		0.294 (0.564)	0.293 (0.570)		0.044 (0.101)	0.043 (0.101)
Constant	0.064 (0.107)	0.063 (0.107)	0.021 (0.182)	0.174 (0.115)	0.174 (0.116)	0.676* (0.370)
Observations	719	719	719	1009	1009	1009
Individuals	150	150	150	150	150	150
Characteristics Controls	No	No	Yes	No	No	Yes

<sup>1</sup> Standard errors clustered at individual level are in parenthesis. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ .

<sup>2</sup> The dependent variables of Model (1) and (2) are the risk attitude measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the dependent variables of Model (3) and (4) are the risk attitude measured by the SOEP survey question. All variables are standardized to mean 1 and standard deviation 1.

<sup>3</sup> Individual characteristics controls include race dummies.

Table A8: Panel Regressions: Impact of Negative Emotion on Risk Tolerance (Unbalanced Class of 2020)

	DV: Lottery Choice		DV: SOEP Survey Measure	
	(1)	(2)	(3)	(4)
Female	-0.549*** (0.087)	-0.556*** (0.086)	-0.242*** (0.086)	-0.241*** (0.087)
Sadness and Fear	-0.052 (0.062)	-0.063 (0.061)	-0.129** (0.058)	-0.128** (0.058)
Female $\times$ Sadness and Fear	0.033 (0.080)	0.044 (0.079)	0.100 (0.070)	0.097 (0.071)
Anger and Hostility	-0.052 (0.075)	-0.056 (0.074)	0.071 (0.061)	0.072 (0.061)
Female $\times$ Anger and Hostility	0.095 (0.104)	0.095 (0.103)	-0.079 (0.071)	-0.082 (0.071)
Constant	0.330*** (0.070)	0.458*** (0.154)	-0.055 (0.066)	0.133 (0.203)
Observations	621	621	1124	1124
Individuals	410	410	427	427
Characteristics Controls	No	Yes	No	Yes

<sup>1</sup> This table includes all participants from the Class of 2020, which is an unbalanced panel;

<sup>2</sup> Standard errors clustered at individual level are in parenthesis. \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ ;

<sup>3</sup> The dependent variables of Model (1) and (2) are the risk attitude measured by the lottery choice in [Eckel and Grossman \(2008\)](#), and the dependent variables of Model (3) and (4) are the risk attitude measured by the SOEP survey question. All variables are standardized to mean 1 and standard deviation 1;

<sup>4</sup> The variables “Sadness and Fear” and “Anger and Hostility” are the two factor scores from the factor analysis over subjects’ responses to the questions on frequencies of 10 different negative emotions;

<sup>5</sup> Model (1) and (2) includes data from Waves 4 and 7, because we did not include the lottery choice task in Waves 5 or 6. Model (3) and (4) includes data from Waves 4, 5, 6, and 7, as we collected the SOEP survey risk measure for all these waves;

<sup>5</sup> Individual characteristics controls include race dummies.

## B Screenshots of Tasks

**Task 7**

In this task you will select, from six different options, the one that you most prefer. The one you choose will determine your payoffs for this task. The six different options are illustrated below. (This is just an illustration, you will make your actual decision later.)

Each option has two possible outcomes, Low or High. For every option, each outcome is equally likely, or has a 50% chance of happening. At the end of the study, the computer will randomly choose a number between 1 and 10. If the number is 1-5, then you will earn the Low payoff; if it is 6-10 you will earn the High payoff.

For example, if you choose option 1, you will receive \$10.00 for sure; if you select option 4 you will earn \$4.00 if the computer draws a number between 1 and 5 and \$22.00 if the computer draws a number between 6 and 10.

Option	Low Payoff	High Payoff
1	\$10.00	\$10.00
2	\$8.00	\$14.00
3	\$6.00	\$18.00
4	\$4.00	\$22.00
5	\$2.00	\$26.00
6	\$0.00	\$28.00

Continue

Figure B1: Screenshot: Instruction for Eckel-Grossman Lottery Choice Task

**Decision Screen**

You must select one of these options. To select an option, click on the button next to that option and the SUBMIT button will appear.

Your earnings for this task will be determined by: which of the six options you select; and the number drawn by the computer.

Option	Low Payoff	High Payoff
<input type="radio"/> 1	\$10.00	\$10.00
<input type="radio"/> 2	\$8.00	\$14.00
<input type="radio"/> 3	\$6.00	\$18.00
<input type="radio"/> 4	\$4.00	\$22.00
<input type="radio"/> 5	\$2.00	\$26.00
<input type="radio"/> 6	\$0.00	\$28.00

Review the instructions.  
REVIEW

Figure B2: Screenshot: Decision Screen for Eckel-Grossman Lottery Choice Task



In **Decision Task 5** you will select, from six different options, the one that you most prefer. The option you choose will determine your payoffs for this task.

The six different options are illustrated below.

Each option has two possible outcomes, Low or High. For every option, each outcome has a 50% chance of happening.

At the end of the study, the computer will randomly choose a number between 1 and 10. If the number is 1-5, then you will earn the Low payoff; if it is 6-10 you will earn the High payoff.

For example, if you choose option 1, you will receive \$10 for sure; if you select option 4 you will earn \$4 if the computer draws a number between 1 and 5 and \$22 if the computer draws a number between 6 and 10.

Please select one option.

Keep in mind that if this task is selected for payment, your earnings will be determined by: Which of the six options you select; and the number drawn by the computer.

Low: \$10.00; High: \$10.00

Low: \$8.00; High: \$14.00

Low: \$6.00; High: \$18.00

Low: \$4.00; High: \$22.00

Low: \$2.00; High: \$26.00

Low: \$0.00; High: \$28.00

Figure B3: Screenshot: Instruction and Decision Screen for Eckel-Grossman Lottery Choice Task in Wave 7

Note. In Wave 7, we employed a different outlook of instruction and decision screen for the Eckel-Grossman task. Notice that the incentive structure is still consistent with this task in previous waves.

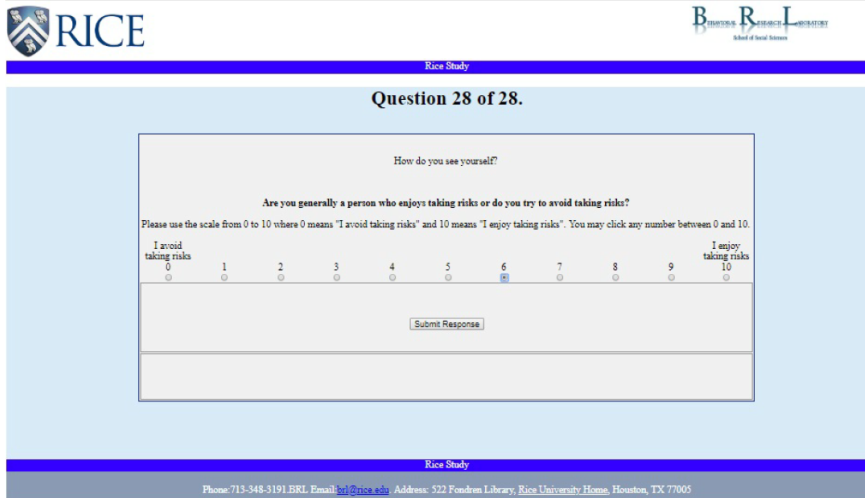


Figure B4: Screenshot: Survey Measure from Germany Socio-Economic Panel

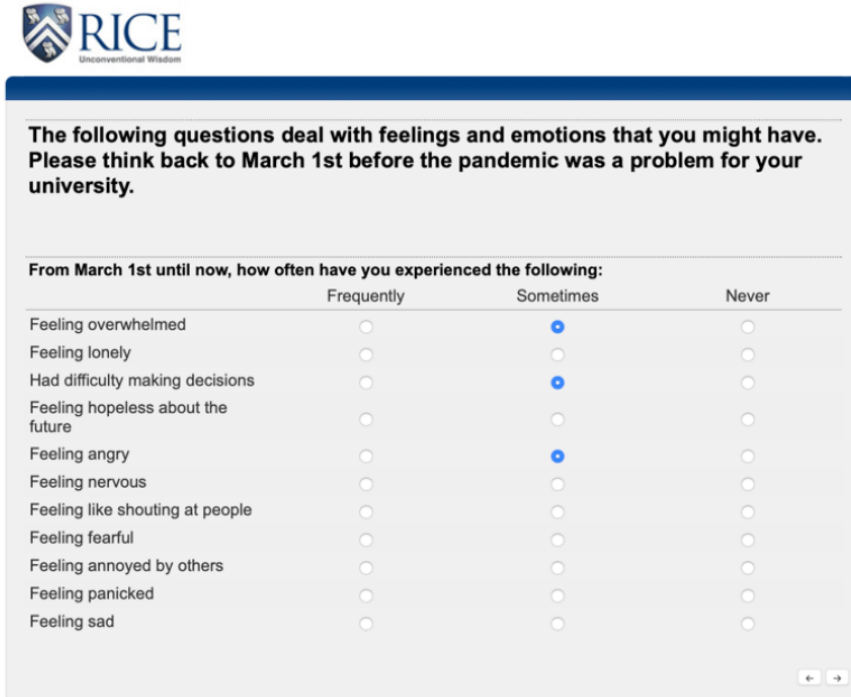


Figure B5: Screenshot: Negative Emotions