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# “Risk Taking and Skewness Seeking Behavior in a Demographically Diverse Population”

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**Risk Taking and Skewness Seeking Behavior in a Demographically Diverse Population***

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**Abstract:** We study the interaction between risk taking and skewness seeking behavior among the French population using an experiment that elicits certainty equivalent over lotteries that vary the second and third moments orthogonally. We find that the most common behavior is risk avoidance and skewness seeking. On average, we find no interaction between the two, and a weakly significant interaction only in some segments of the population. That is, in most cases, skewness seeking is not affected by the variance of the lotteries involved, nor is risk taking affected by the skewness of the lotteries. We also find a significant positive correlation between risk avoiding and skewness seeking behavior. Older and female participants make more risk avoiding and more skewness seeking choices, while less educated people and those not in executive occupations are more skewness seeking.

**Keywords:** Risk; Skewness; Certainty Equivalent; Experiment

**JEL classification:** C93; D81

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# 1. Introduction

While studying higher order risk preferences has become increasingly common in recent years, the interaction between risk taking and skewness seeking behavior remains understudied. Understanding the tradeoffs that people make when choosing among options that vary in both risk and skewness has important economic implications. To begin with, the well-known “favorite - long shot bias” in horse race betting is attributed to a preference for skewness that is sufficiently strong to overcome aversion to risk and lower expected returns (Golec and Tamarkin, 1998). More importantly, the skewness of future earning distributions is shown to significantly influence labor market choices. For example, Flyer (1997) shows how the higher order moments of the earnings distribution influences the initial career decisions of college graduates, while both Grove et al. (2021) and Choi et al. (2021) demonstrate the influence of highly skewed earnings distributions on entry into superstar markets. The latter also show that the costs (in lower wages) of these choices can be substantial and long lasting. Tradeoffs between risk taking and skewness seeking also influence whether farmers adopt new agricultural technologies, which generally change both the skewness and variance of crop yields (Chavas and Shi 2015, Emerick et al. 2016), and their purchases of crop insurance.

By using a carefully designed experiment, we can vary the risk and skewness of lottery options in a controlled orthogonal way. The main novelty of our study is to investigate the interaction between risk taking and skewness seeking behavior among a diverse population, specifically a sample of French adults who are demographically diverse in terms of age, education, and occupation. We find that the most common behavior is risk avoidance and skewness seeking but on average the two do not interact with each other. That is, the risk taking behavior of our sample is mostly unaffected by the skewness of the options, and similarly, skewness seeking behavior is unaffected by the variance of the options. We find a weakly significant positive interaction effect only in some segments of the population. This segment containing the most risk avoiding subjects, takes more risk as the skewness of the options increases and vice versa.

Our finding of no interaction effect on average among a diverse population contrasts with results found in lab studies using student subjects, where the common finding is of greater risk taking when facing options with greater skewness; that is, a positive interaction effect. In particular, Grossman and Eckel (2015) find a positive interaction effect using a variation of their Eckel and Grossman (2002, 2008) risk elicitation task, Astebro et al. (2015) instead use a variation of the Holt and Laury (2002) risk elicitation task, and Ebert (2015) has subjects choosing among binary lotteries. These three studies all consider only right-skewed lotteries. Dertwinkel-Kalt and Köster (2020) also find evidence of what they call "skewness-dependent risk attitudes" in their Experiment 1, with subjects more willing to choose the lottery over the safe option yielding the lottery's expected value as the skewness of the lottery increases. Their experiment involves negative, zero, and positive skewness lotteries. On the other hand, Taylor (2020) shows that after controlling for the order effects in the Grossman and Eckel (2015) design, the impact of skewness on risk taking becomes mixed with changes observed in both directions, and Bougherara et al. (2021) find that subjects were more willing to take risks when facing more left-skewed lotteries.[1] Except for Astebro et al. (2015), these papers use only student subjects. Astebro et al. (2015) find no difference in how skewness affects risk taking behavior comparing students and executives, which might be explained by the similarity in education levels. We therefore contribute to this literature by studying how risk taking is

[1] Some of these differences in results might be attributable to loss aversion as Grossman and Eckel (2015) and Bougherara et al. (2021) use mixed lotteries, while Astebro et al. (2015) uses only lotteries involving gains. Bleichrodt and van Bruggen (2020) find the standard result of risk aversion and prudence over lotteries involving only gains but find that risk loving and imprudence is common for lotteries involving only losses.

affected by skewness, as well as how skewness seeking behavior is affected by the risk of the lottery, and the interaction of both, in a demographically diverse population.[2]

While our study is novel in investigating the interaction between skewness seeking and risk taking in the general population, both prudence and risk preference have been separately studied among the general population, as well as among children and adolescents.[3] Noussair et al. (2014) study prudence among a large sample of Dutch adults finding that most respondents are risk averse and prudent. However, compared to a lab sample of student subjects, the panel was less prudent, which the authors attribute to the effect of education as regressions reveal that more highly educated participants are more prudent, with other demographics not significant. Haering et al. (2020) study the effect of culture, using student subjects in lab experiments conducted across three countries: China, US, and Germany. They find no significant differences in prudence across cultures. Heinrich and Shachat (2020) find that Chinese children and adolescents are mostly prudent, while Fairley and Sanfey (2020) have a similar finding among Dutch adolescents. The latter also find a positive correlation between IQ score and prudence. In summary, while considerable heterogeneity is observed in prudence across the population, other than education and cognitive ability, demographic factors such as gender and age do not seem to be correlated with prudence.[4]

Several studies measure risk preferences using incentivized methods among the general population (Harrison et al., 2007, Dohmen et al., 2010, 2011; von Gaudecker et al., 2011).[5] Like the prudence results, considerable heterogeneity is observed although risk aversion is the

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[2] Apart from Bougherara et al. (2021), we know of only one other study that asks this reverse question although this is not isolated in the experimental design but revealed in regression results. Specifically, Brünner et al. (2011) finds that higher variance generates more skewness-seeking choices in their experiment using binary lotteries.

[3] Prudence is a stricter feature of preferences, implying skewness seeking behavior that is robust to different levels of kurtosis. Trautmann and van de Kuilen (2018) survey the growing number of experimental studies that study prudence. Ebert and Wiesen (2011) find evidence of prudence, with most prudent subjects also being skewness seeking but not necessarily vice versa.

[4] Within a student subject pool, Breaban et al. (2016) also find that higher cognitive ability is correlated with greater prudence. Noussair et al. (2014) have the same finding among their student sample.

[5] While Charness et al., (2020) elicit risk preferences among a sample of Dutch adults they focus on linking with financial decisions and do not report the link with socio-demographic factors.

modal outcome. Although demographic factors seem to matter more here than for prudence, it is hard to reach firm conclusions because results vary considerably with the methods employed. For example, with regard to gender, von Gaudecker et al. (2011), Dohmen et al. (2011) and Noussair et al. (2014) find that women take less risk, while Harrison et al. (2007) finds no effect.[6] Effects regarding age are also mixed with von Gaudecker et al. (2011) finding that risk taking decreases with age, while Harrison et al. (2007), Dohmen et al. (2010), and Noussair et al. (2014) find that older people are less risk averse.[7] Similarly, greater education can increase risk aversion (Harrison et al., 2007) or the opposite (von Gaudecker et al., 2011) or have no effect (Dohmen et al., 2010; Noussair et al, 2014). Only Dohmen et al. (2010) study the role of cognitive ability, finding a positive correlation between risk taking and cognitive ability. The impact of income or wealth is similarly mixed with von Gaudecker et al. (2011) finding no significant effects, while Dohmen et al. (2010, 2011) and Noussair et al. (2014) find a positive correlation between higher wealth or income and risk taking. In summary, while it is hard to reach general conclusions, demographic differences matter for risk taking behavior, which reinforces the need to study the interaction between risk taking and skewness seeking behavior among a broader population than the standard lab sample. While our primary contribution is to study the interaction between risk taking and skewness seeking among a diverse sample, we are also novel in measuring skewness seeking (rather than prudence) in a broader sample. Finally, we also contribute further evidence to the small literature on risk taking in diverse populations.

To study the interaction between risk taking and skewness seeking behavior, our experiment employs a design that varies the variance and skewness of lotteries in an orthogonal fashion. By eliciting certainty equivalents for each lottery, we measure the intensity of

[6] According to Filippin and Crosetto (2016) this null effect could be due to Harrison et al. (2007) using the Holt and Laury (2002) risk elicitation task. In contrast, Dohmen et al. (2010) elicit certainty equivalents, while von Gaudecker et al. (2011) and Noussair et al. (2014) use lottery choices.

[7] Dohmen et al. (2017) also find that risk taking decreases with age based on self-reported measures.

preferences and therefore can examine the tradeoffs we are interested in. To examine if our results are robust to different directions of skewness, we include lotteries that are both negatively, positively, and zero skewed. All our lotteries involve only gains to avoid any confound from loss aversion.

Our basic experimental design follows the first part of Bougherara et al. (2021), however the stakes are substantially increased, the lotteries only involve gains (rather than mixed lotteries), the subject pool is more diverse with that experiment conducted using university students, and a zero-skew lottery is included. In addition, that paper focused on explaining individual decisions and so involved a second lottery task used for that purpose.

Finally, note that we study skewness seeking behavior rather than prudence.[8] We define skewness seeking as preferring a lottery with a larger skewness over another lottery with a smaller skewness but the same expected value, variance, and kurtosis (Ebert and Wiesen, 2011). Since we consider both right- and left-skewed lotteries, a larger skewness can therefore mean either a more right-skewed lottery or a less left-skewed lottery. Similarly, we study "risk taking" rather than risk preference, with the former referring to preferences over changes in standard deviation holding the other moments constant.

In summary, we find that the most common behavior among French adults is risk avoidance and skewness seeking regardless of the direction of skewness involved. However, on average we find no interaction between the two. That is, skewness seeking is not affected by the variance of the lotteries involved, nor is risk taking affected by the skewness of the lotteries. We find a weakly significant positive interaction effect in some segments of the population. We also find a significantly positive correlation between risk avoiding and skewness seeking behavior, that older and female participants make more risk avoiding and

[8] As noted earlier, prudence is a stricter feature of preferences, implying skewness seeking behavior that is robust to different levels of kurtosis.

skewness seeking choices, and that less educated people and those not in executive occupations are more skewness seeking.

## 2. Experimental Design

Our experiment consists of three parts. In the first and main part, we elicit participants' certainty equivalents (CEs) for six different lotteries with varying standard deviation and skewness. Second, we elicit participants' self-assessed risk attitudes over different domains. Third, we elicit basic socio-demographic information. Our experiment is carried out as a web survey with the instructions shown on a video. Experimental instructions for all parts (translated from French) are provided in Appendix A.

We designed six lotteries, shown in Table 1, that vary in skewness and standard deviation but have the same expected value (€75) and kurtosis (2). Each lottery is defined as {(X1, 0.5), (X2, 0.25), (X3, 0.25)}, with X1, X2, X3 representing the outcomes and 0.5, 0.25 and 0.25 their respective probabilities. All amounts are in Euros (€).[9] Note that lotteries with three possible outcomes are required to vary the skewness while keeping the kurtosis, mean, and standard deviation the same. We keep the probabilities fixed while varying the outcomes, and all lotteries involve only gains to avoid potential confounds with loss aversion.

Half of the lotteries (A, B, C) are less risky and have a lower standard deviation than the other three lotteries (D, E, F). Within each set of lotteries with the same standard deviation, we vary the skewness over three levels: negative, zero and positive, where the negative and positive skewness is of the same absolute magnitude (0.8). This orthogonal design enables us to study how participants trade off standard deviation and skewness in a controlled manner. To control for potential order effects, we created six sequences that were randomized across subjects (ABCDEF, FABCDE, EFABCD, DEFABC, CDEFAB, BCDEFA).

[9] For ease of presentation and to avoid confusion, we rounded the amounts to whole Euros.

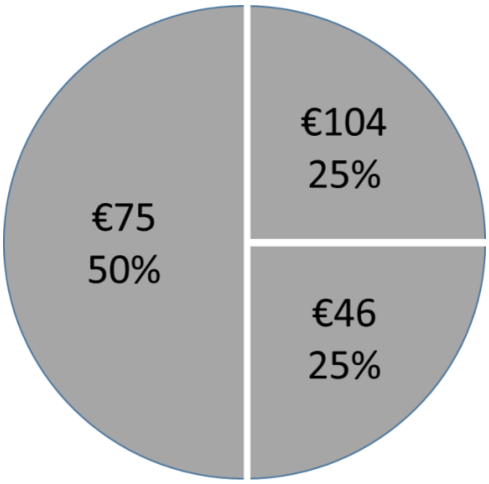
**Table 1. Lottery characteristics**

| Lottery | X1 (p=0.5) | X2 (p=0.25) | X3 (p=0.25) | Expected Value | Standard Deviation | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| A | 75 | 104 | 46 | 75 | 20 | 0.0 | 2.0 |
| B | 58 | 108 | 75 | 75 | 20 | 0.8 | 2.0 |
| C | 92 | 75 | 42 | 75 | 20 | -0.8 | 2.0 |
| D | 75 | 30 | 120 | 75 | 32 | 0.0 | 2.0 |
| E | 49 | 127 | 75 | 75 | 32 | 0.8 | 2.0 |
| F | 101 | 23 | 75 | 75 | 32 | -0.8 | 2.0 |

Note: Only the information contained in columns 2 to 4 is provided to the subjects.

To elicit certainty equivalents, we follow standard methods used in the risk preference literature (Etchart-Vincent and L'Haridon, 2011; Cubitt et al., 2015; Diecidue et al., 2015). In particular, subjects are asked to repeatedly choose between a sure amount and the particular lottery, where the sure amount varies from the lowest lottery outcome to the highest in €5 steps. To reduce the noise in the data we constrain subjects to switch from the sure amount to the lottery only once. To help participants understand the chances we included a graphical representation as illustrated in Figure 1.

Lottery




| I prefer: | |
|---|---|
| the lottery ☐ | ☐ the sure amount of €45 |
| the lottery ☐ | ☐ the sure amount of €50 |
| the lottery ☐ | ☐ the sure amount of €55 |
| the lottery ☐ | ☐ the sure amount of €60 |
| the lottery ☐ | ☐ the sure amount of €65 |
| the lottery ☐ | ☐ the sure amount of €70 |
| the lottery ☐ | ☐ the sure amount of €75 |
| the lottery ☐ | ☐ the sure amount of €80 |
| the lottery ☐ | ☐ the sure amount of €85 |
| the lottery ☐ | ☐ the sure amount of €90 |
| the lottery ☐ | ☐ the sure amount of €95 |
| the lottery ☐ | ☐ the sure amount of €100 |
| the lottery ☐ | ☐ the sure amount of €105 |

**Fig. 1. Example of a typical decision task (lottery A)**

In the second part of the experiment, we collected a self-assessment of risk attitudes using two approaches that were easy to implement and less demanding for subjects than using another set of lottery choices. First, we used the generalized risk question from Dohmen et al. (2011) who found a strong correlation between this measure and an incentivized experimental measure of risk taking. Subjects are asked to rate their attitude towards risk taking in general on a scale from 0 (not at all willing to take risks) to 10 (very willing to take risks). Second, we also collected a self-assessment of risk attitudes in different domains using the French version of the 30-item domain-specific risk-taking (DOSPERT) scale of Blais and Weber (2006). Subjects indicated the likelihood that they would engage in a particular activity or behavior on a scale from 1 (Extremely unlikely) to 7 (Extremely likely) for 30 items, which are made up of six questions in each of five domains (social, recreation, ethical, financial, and health). The financial domain is further divided into gambling and investment questions (three items each). We also construct an overall (global) measure which is the sum of all items. All these variables are proxies for risk attitude, a key variable to explain lottery choices. Finally, participants answered a short demographic questionnaire collecting information on age, gender, income, education, and occupation.

A French crowdsourcing company (*Foule Factory*) conducted the experiment using their existing panel of participants.[10] Participants undertook the survey at their own convenience on their own devices. In total, the survey took around 15 minutes to complete. There were 308 participants. Fifteen randomly chosen subjects (approximately 5% of the participants) were paid for one randomly selected lottery decision. In particular, one row for this decision task was drawn randomly. If for the selected row the subject preferred the sure

[10] Like Amazon Mechanical Turk, Foule Factory is a crowdsourcing company (for further discussions, see e.g., Barraud de Lagerie and Sigalo Santos, 2018; Renault, 2018). It was created in 2014 and claims 50,000 workers exclusively residing in France. This platform allows clients to offer tasks to registered workers, microtasks or more demanding tasks, sometimes requiring qualifications. A very active worker will earn a monthly average of around €40. Earnings (capped at €3,000 per year) are additional income for the workers.

amount to the lottery, then the payment was equal to this sure amount. If for the selected row the subject chose the lottery instead of the sure amount, then the lottery was played, and the payment was equal to the outcome of the lottery. Such selective payment methods are commonly used in field experiments measuring risk preferences (Harrison et al., 2007; Dohmen et al., 2010; von Gaudecker et al., 2011; Noussair et al., 2014). Average earnings of the 15 randomly chosen subjects were €74.53. This was in addition to the standard Foule factory payment of €0.14 per minute paid to all subjects (equivalent to around €2 for a 15-minute experiment).

## 3. Descriptive analysis of the experiment results

We first infer average behavior in the pool of subjects in relation to variance and skewness from the comparison of mean CEs across the six lotteries (Section 3.1). Then, in Section 3.2, we look more closely at the choices made by each subject to elicit patterns in individual subjects' behavior with respect to the second and third moments of the six lotteries. In Section 3.3, we present the socio-demographic characteristics and self-assessment of risk attitudes for the population under study.

### 3.1 Average behavior with respect to variance and skewness

In all that follows, the certainty equivalent (CE) is the value of the sure amount on the next row after the player has switched from the lottery to the sure amount. It is measured in Euros (€). Table 2 shows summary statistics on CEs for each of the six lotteries, ordered from the highest to the lowest mean CE. The mean elicited CE varies from €62.4 for lottery F to €74.4 for lottery B. Mean and median CEs are at their lowest for lotteries C and F, which are the two lotteries exhibiting negative skewness. On the contrary, the mean and median CEs are at their highest for the two lotteries characterized by positive skewness (B and E). Standard deviation of CEs (and thus heterogeneity in CEs) is higher for lotteries E, F and D, which are the lotteries exhibiting the highest standard deviation.

**Table 2. Summary statistics on elicited CE for each lottery (amounts in €)**

| Lottery characteristics | | | Statistics on elicited CEs | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Lottery | Std Dev. | Skew. | Mean CE | Std. Dev. | Min CE | Max CE | 1st Quart. | Me -dian | 3rd Quart. |
| B | 20 | 0.8 | 74.4 | 15.0 | 55 | 110 | 60 | 75 | 80 |
| E | 32 | 0.8 | 72.5 | 21.7 | 45 | 130 | 55 | 70 | 80 |
| A | 20 | 0.0 | 70.1 | 16.6 | 45 | 105 | 55 | 75 | 80 |
| D | 32 | 0.0 | 67.9 | 24.5 | 30 | 120 | 50 | 75 | 80 |
| C | 20 | -0.8 | 65.4 | 17.5 | 40 | 95 | 50 | 65 | 80 |
| F | 32 | -0.8 | 62.4 | 25.8 | 20 | 105 | 45 | 65 | 80 |

Figure 2 below locates the six lotteries on a space featuring skewness on the horizontal axis (from negative on the left to positive skewness on the right) and standard deviation on the vertical axis (from small at the bottom to large standard deviation at the top). For example, lottery C is characterized by a small standard deviation and a negative skewness while lottery E has a large standard deviation and positive skewness. The figures close to the circles around lottery names are the mean CEs expressed in Euros. We run two-sided paired t-tests on mean CEs and report the sign and significance of the mean comparison next to each arrow. As an example, the mean CE for lottery D (€67.9) is found to be statistically larger than the mean CE for lottery C (€65.4) at the 10% level of significance.

The six horizontal comparisons (F versus D, D versus E, F versus E, C versus A, A versus B, and C versus B) show that the respondents are consistently skewness-seeking since more skewed (right) lotteries are always preferred to lower skewed (left) lotteries with the same expected value, standard deviation, and kurtosis. The pattern is the same whether the standard deviation is low (C versus A, A versus B, and C versus B) or high (F versus D, D versus E, and

F versus E). The six differences between the average CEs are all significant at the 1% level (t-tests outcomes for only four differences are shown on Figure 2 to avoid overloading the graph).

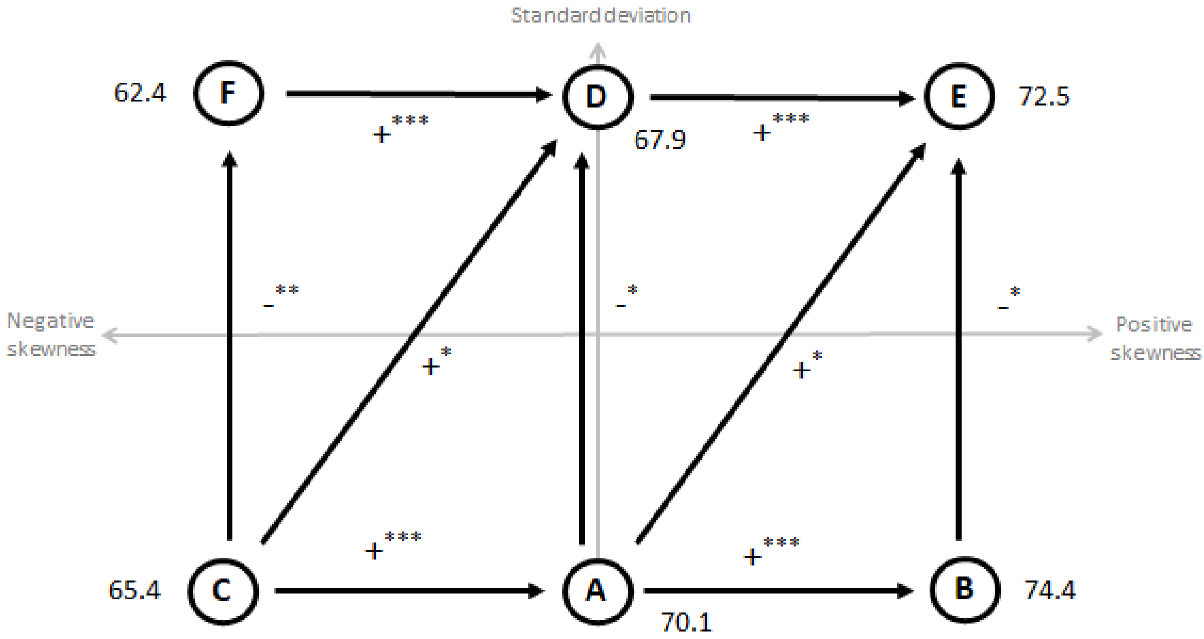



**Fig. 2. Mean certainty equivalent for each lottery**

Notes: all values in €; the arrows show the direction and significance of two-sided paired t-tests of CEs; *** p<0.01, ** p<0.05, * p<0.10.

The three vertical comparisons show that, whatever the level of skewness (negative, zero or positive), lotteries with a higher standard deviation are valued less. The difference in average CEs is significant at the 5 or 10% level.

The diagonal comparisons indicate that the (positive) skewness effect dominates the (negative) standard deviation effect: the average CE is significantly higher (at the 10% level) in lotteries with both a higher standard deviation and which are more right-skewed (C versus D, and A versus E).

Finally, we check if the difference in CEs between two lotteries of equal skewness (F vs C, D vs A, and E vs B) varies with the level of risk (as measured by standard deviation).

Paired t-tests between the three differences are not statistically different from zero. Hence, we do not observe any change in risk-taking when the level of skewness increases.

### 3.2 Individual behavior with respect to variance and skewness

We next infer individual-level behavior with respect to skewness by considering the six horizontal pairwise comparisons. We define a subject as a skewness-seeker for a particular comparison if: $CE_A > CE_C$; $CE_B > CE_A$; $CE_D > CE_F$; $CE_E > CE_D$; $CE_E > CE_F$; $CE_B > CE_C$, where the indexed letter refers to the lottery. Similarly, a subject is considered skewness-neutral if: $CE_A = CE_C$; $CE_B = CE_A$; $CE_D = CE_F$; $CE_E = CE_D$; $CE_E = CE_F$; $CE_B = CE_C$ or a skewness-avoider if: $CE_A < CE_C$; $CE_B < CE_A$; $CE_D < CE_F$; $CE_E < CE_D$; $CE_E < CE_F$; $CE_B < CE_C$.

Figure 3 shows the proportion of subjects classified in each of the three groups. The pattern is similar for the first four (horizontal) pairwise comparisons with, in each case, 56 to 58% of subjects classified as skewness-seekers, 20 to 23% as skewness-neutral, and 20 to 23% as skewness-avoiders. For the last two comparisons (E versus F and B versus C), we observe a larger proportion of skewness-seekers (62% and 68%, respectively). These two comparisons are between lotteries for which the difference in skewness is at its maximum (1.6 instead of 0.8 for the first four comparisons).

While these comparisons reveal that the most common behavior is skewness seeking (consistent with the average results reported in the previous section), they also reveal a large minority of behavior that is not skewness seeking (as high as 44% of lottery comparisons). We checked the consistency of subjects' choices by counting the number of times that each subject exhibited skewness-seeking behavior out of the six lottery comparisons above, with the results shown in Figure 4.

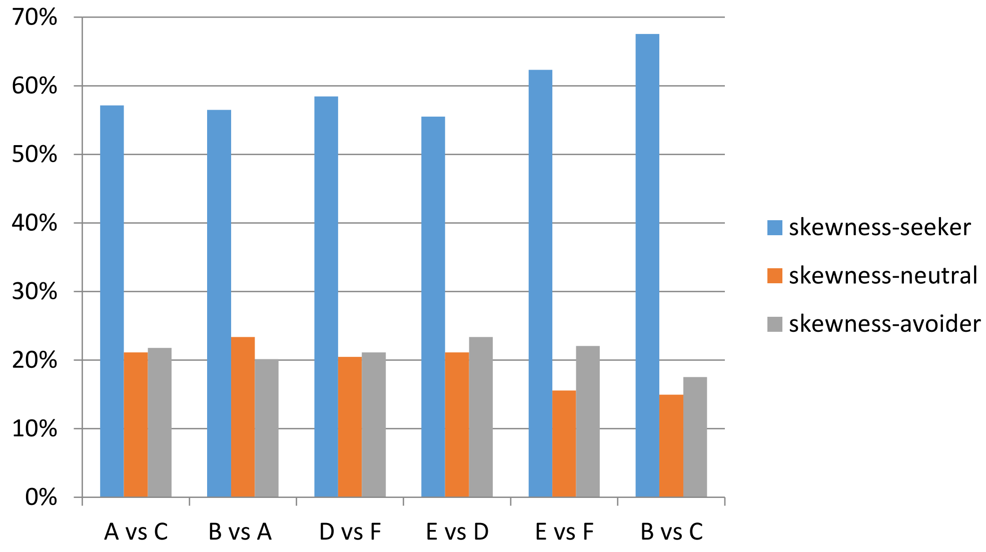



**Fig. 3. Behavior with respect to skewness inferred from pairwise lottery comparisons**

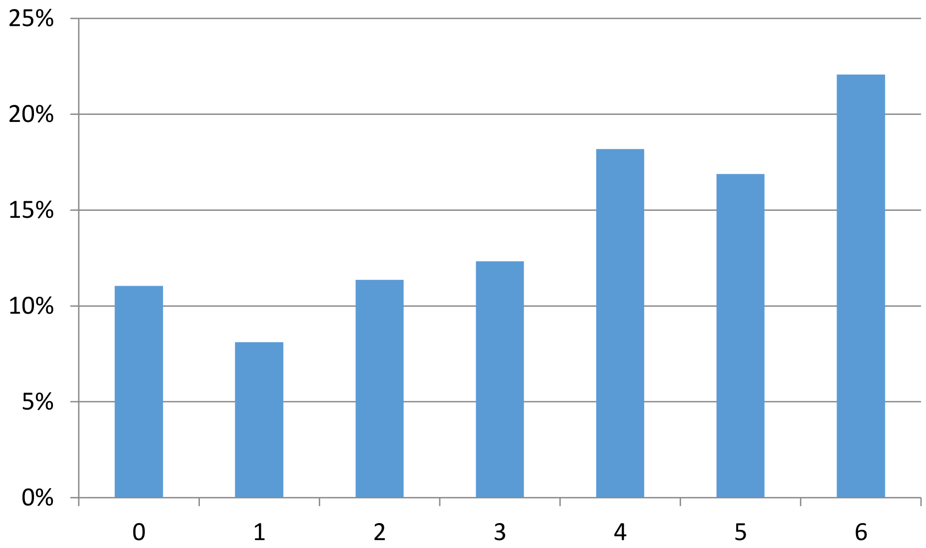



**Fig. 4. Number of times subjects exhibit skewness-seeking behavior**

Around one-third of the subjects are fully consistent in either always exhibiting skewness-seeking behavior (22% of the sample) or never showing such behavior (11%). When looking at skewness-avoiding behavior (figure not shown here), we find that 139 subjects (45%) never exhibit skewness-avoiding behavior while three subjects always exhibit such behavior.

Individual behavior with respect to standard deviation or, equivalently, to variance, can be inferred through the three vertical pairwise comparisons. We define a subject as a risk-taker if: $CE_F > CE_C$; $CE_D > CE_A$; $CE_E > CE_B$; risk neutral if: $CE_F = CE_C$; $CE_D = CE_A$; $CE_E = CE_B$, or risk-avoider if: $CE_F < CE_C$; $CE_D < CE_A$; $CE_E < CE_B$. As for the case of skewness, Figure 5 shows significant heterogeneity in the population with 45 to 51% of the subjects being classified as risk-avoiders, 19 to 24% as risk-neutral, and 26 to 31% as risk-takers. (This corresponds to the weaker differences in CEs we found in the vertical lottery comparisons.)

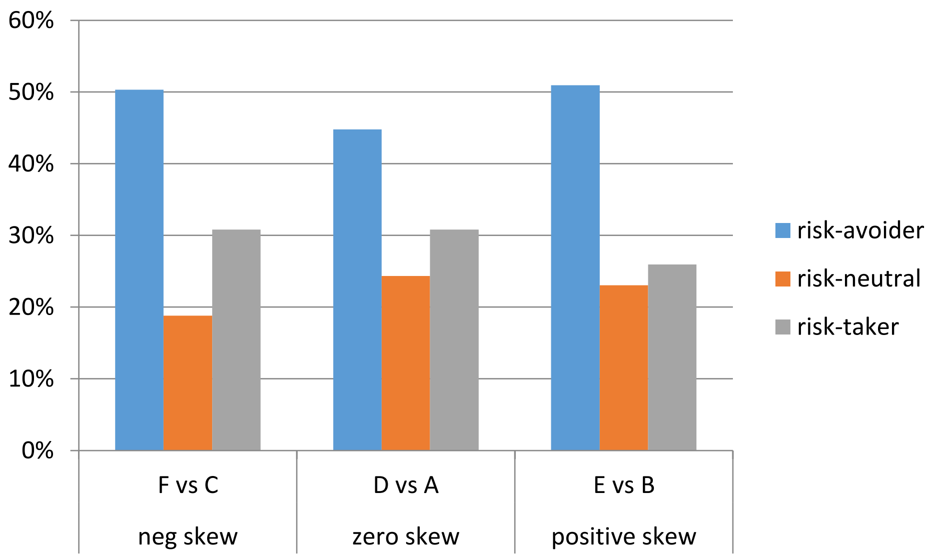



**Fig. 5. Behavior with respect to risk inferred from pairwise lottery comparisons**

In Figure 6 we check for the consistency of choices in relation to risk-avoiding behavior by counting the number of times each subject exhibits risk-avoiding behavior among the three lottery comparisons. Around half of our subjects make consistent choices by either always being risk-avoiding (25%) or never being risk avoiding (25%). The remainder change their behavior depending on the skewness of the lotteries being considered.

Finally, we computed the Spearman rank correlation coefficient between the number of risk-avoiding choices and the number of skewness-seeking choices, finding a strongly significant positive correlation of 0.51 (p-value = 0.000).[11] Thus, more skewness-seeking subjects are also more likely to make risk-avoiding choices.

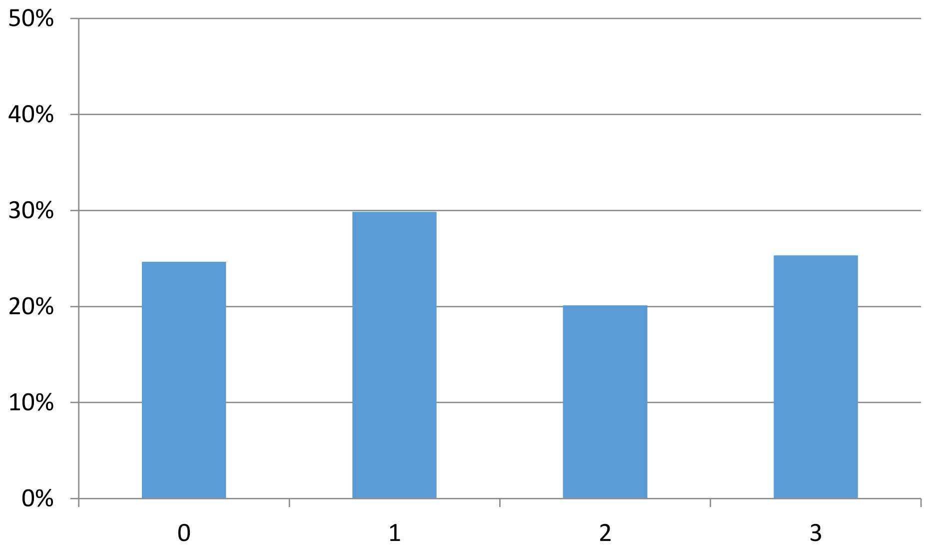



**Fig. 6. Number of times subjects exhibit risk-avoiding behavior**

### 3.3 Socio-demographic statistics and self-assessment of risk attitudes

We first present some basic summary statistics on the socio-demographic characteristics of the 308 subjects in Table 3. Among the 308 subjects, 56% are male and our population is aged 40 on average. The education level is coded from 0 (no training beyond the first four years of secondary education) to 7 (Master's degree or beyond) in the questionnaire; see Appendix A for details of each code. The average education level on our sample is between level 4 and 5, where 5 stands for achievement of a Bachelor's degree and 4 corresponds to one or two extra years after the French *baccalaureat* (equivalent to US high-school diploma). This corresponds to 75% of the subjects having a higher education, where higher education is defined by one year of education or more after the *baccalauréat*. Our pool of subjects is

[11] Noussair et al. (2014) also report a significant positive correlation between risk aversion and prudence among their panel although from actual lottery choices rather than inferred from CEs.

younger and more educated than the general French population (see Appendix B for national statistics on gender, age, and education level). Close to 20% of our subjects occupy an executive or senior intellectual job.[12] A total of 13 subjects out of 308 (4%) did not provide their income category. We created a continuous (individual) income variable from the seven categories. For each of the income intervals, the continuous measure was set equal to the interval mid-point. For the only subject who reported an income above €6,500, we set the continuous income measure at €6,500. The average monthly income on our sample is €1,777. The distribution of monthly income for the 295 subjects who responded to the question is shown in Appendix C.

**Table 3. Socio-demographic characteristics of our pool of subjects (N = 308)**

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Age (years) | 40.2 | 13.0 | 18 | 76 |
| Subject is a male (0/1) | 56.2% | 49.7% | 0% | 100% |
| Education level (0 to 7) | 4.6 | 1.6 | 0 | 7 |
| Higher education (0/1) | 74.7% | 43.6% | 0% | 100% |
| Executives, senior intellectual jobs (0/1) | 18.5% | 38.9% | 0% | 100% |
| Monthly income (continuous measure, in €), N = 295 | 1,777 | 1,019 | 550 | 6,500 |

Each subject was asked to assess his/her own willingness to take risk from a scale varying from 0 (highly cautious, not willing to take risks) to 10 (fully prepared to take risks). The distribution in Figure 7 shows heterogeneity in risk attitudes. It is characterized by an average risk-taking score of 4.3 and a mode around 5 and 6, in line with results presented in

[12] Due to technical problems when implementing the web survey, some intermediate occupations did not appear on the screen and therefore could not be chosen by the subjects. However, from the answers that have been recorded, we believe that those subjects who could not select the intermediate occupation category selected a category that was below their current level, since the percentage of subjects in lower occupation seems to be high compared to the general population. On the contrary, we are confident that the measurement of the executive and senior intellectual jobs is fairly accurate, hence our choice of this measure.

Dohmen et al. (2011) for a large representative sample of German adults. Only 1% of subjects chose the value 10, while 7% chose 0.

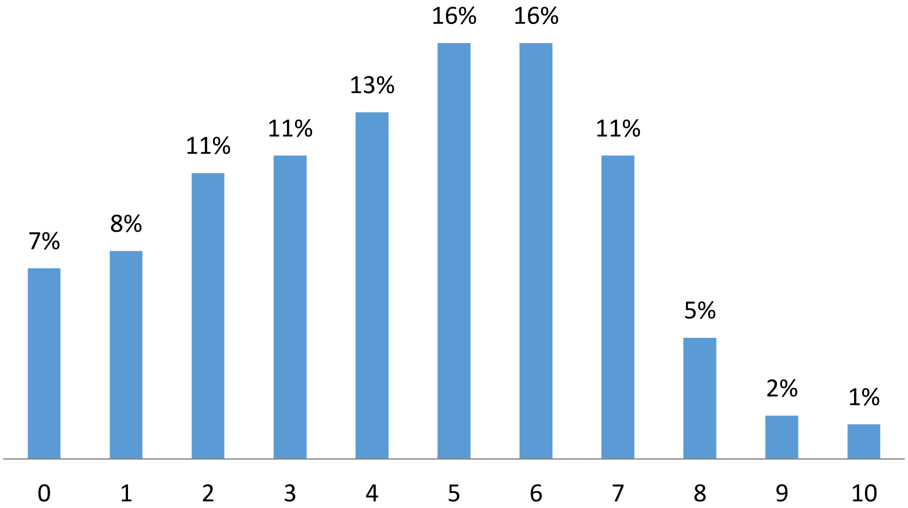



**Fig. 7. Distribution of risk-taking scores among the 308 subjects**

Each subject also answered a typical DOSPERT questionnaire (see Appendix A). Statistics on the global score from DOSPERT questionnaire and the five DOSPERT scores are shown in Table 4.

**Table 4. Summary of answers to the DOSPERT questionnaire (N=308)**

| Index | Mean | Std. Dev. | Cronbach's alpha |
|---|---|---|---|
| Global | 97.9 | 26.3 | 0.88 |
| Social | 30.1 | 6.7 | 0.71 |
| Recreational | 19.3 | 9.2 | 0.83 |
| Health | 17.4 | 7.5 | 0.72 |
| Financial | 16.3 | 7.9 | 0.80 |
| *Financial - Investing* | 9.9 | 4.8 | 0.74 |
| *Financial - Gambling* | 6.4 | 4.7 | 0.87 |
| Ethical | 14.8 | 6.2 | 0.63 |

Subjects are less willing to take risks in the Ethical, Financial, Health, and Recreation domains compared to the Social domain. Within the Financial domain, they are more willing to take risks with investing compared to gambling. For each of the DOSPERT domains we also compute Cronbach's alpha, a measure of consistency. Our results (the Cronbach's alpha varying from 0.63 to 0.88) are generally consistent with earlier findings from the literature (e.g., Blais and Weber 2006; Dohmen et al. 2011, and Reynaud and Couture 2012).[13] In what follows, we consider only the global score from the DOSPERT questionnaire and the score in the recreational and financial domains, which are the most relevant for our purpose.[14]

We now compare the average characteristics of subjects between skewness-seekers and non-skewness-seekers (including both skewness-neutral and skewness-avoiders) as defined in Section 3.2, using two-sided paired t-tests, considering pairwise comparisons of CEs for the three lotteries with small variance (Table 5) and pairwise comparisons for the three lotteries with high variance (Table 6).

Based on these three comparisons, we observe that skewness-seekers are older, less educated, and less likely to have an executive or high intellectual occupation. They are also less willing to take risk (based on the general risk-taking score and the DOSPERT recreational score). We observe similar patterns when comparing the three lotteries with high variance (D, E and F) as shown in Table 6.

[13] See Appendix D for a correlation analysis between the risk-taking score and scores from DOSPERT questionnaire.

[14] Even if lottery games involving possible gains can be seen as financial decisions, the (relatively low) level of stakes may also make our experiment more comparable to risk-taking in the recreational domain (like scratch games people may play from time to time for fun).

**Table 5. Comparisons of characteristics between skewness-seekers and non-skewness seekers (lotteries with small variance)**

| | Lottery A vs Lottery C | | | Lottery B vs Lottery A | | | Lottery B vs Lottery C | | |
|---|---|---|---|---|---|---|---|---|---|
| | skew. seekers | non-skew. seekers | sig. | skew. seekers | non-skew. seekers | sig. | skew. seekers | non-skew. seekers | sig. |
| Age | 41.8 | 38.0 | *** | 42.4 | 37.3 | *** | 41.6 | 37.2 | *** |
| Subject is a male (0/1) | 0.53 | 0.60 | n.s. | 0.51 | 0.63 | ** | 0.51 | 0.67 | *** |
| Higher education (0/1) | 0.69 | 0.83 | *** | 0.68 | 0.83 | *** | 0.70 | 0.84 | *** |
| Income (€) | 1,650 | 1,953 | ** | 1,764 | 1,795 | n.s. | 1,695 | 1,959 | ** |
| Executives and senior intellectual occ. (0/1) | 0.15 | 0.23 | * | 0.13 | 0.25 | *** | 0.15 | 0.25 | ** |
| Risk-taking score | 4.11 | 4.56 | * | 3.86 | 4.87 | *** | 4.13 | 4.65 | * |
| DOSPERT global | 97.4 | 98.6 | n.s. | 94.0 | 103.1 | *** | 96.7 | 100.4 | n.s. |
| DOSPERT recreational | 18.5 | 20.4 | * | 18.5 | 20.3 | * | 18.6 | 20.8 | ** |
| DOSPERT financial | 16.1 | 16.7 | n.s. | 15.2 | 17.9 | *** | 15.9 | 17.4 | n.s. |
| # of subjects | 176 | 132 | | 174 | 134 | | 208 | 100 | |

Note: n.s. is for not significant; *** p<0.01, ** p<0.05, * p<0.10. The group of non-skewness-seekers includes both skewness-neutral and skewness-avoiders. Due to missing observations on income, means are computed from 124 observations in the group of non-skewness seekers and 171 observations in the group of skewness-seekers for the first pairwise comparison. The corresponding numbers are 126 and 169 for the second pairwise comparison, and 92 and 203 for the third pairwise comparison.

**Table 6. Comparisons of characteristics between skewness-seekers and non-skewness seekers (lotteries with high variance)**

| | Lottery D vs Lottery F | | | Lottery E vs Lottery D | | | Lottery E vs Lottery F | | |
|---|---|---|---|---|---|---|---|---|---|
| | skew. seekers | non-skew. seekers | sig. | skew. seekers | non-skew. seekers | sig. | skew. seekers | non-skew. seekers | sig. |
| Age | 41.6 | 38.2 | ** | 42.3 | 37.5 | *** | 42.3 | 36.6 | *** |
| Subject is a male (0/1) | 0.53 | 0.60 | n.s. | 0.53 | 0.60 | n.s. | 0.55 | 0.59 | n.s. |
| Higher education (0/1) | 0.71 | 0.80 | * | 0.68 | 0.83 | *** | 0.69 | 0.84 | *** |
| Income (€) | 1,725 | 1,853 | n.s. | 1,687 | 1,891 | * | 1,711 | 1,889 | n.s. |
| Executives and senior intellectual occ. (0/1) | 0.16 | 0.22 | n.s. | 0.11 | 0.28 | *** | 0.13 | 0.28 | *** |
| Risk-taking score | 3.96 | 4.79 | *** | 3.87 | 4.85 | *** | 3.92 | 4.93 | *** |
| DOSPERT global | 94.7 | 102.4 | ** | 96.2 | 100.0 | n.s. | 96.5 | 100.3 | n.s. |
| DOSPERT recreational | 18.3 | 20.6 | ** | 18.6 | 20.2 | n.s. | 18.6 | 20.4 | * |
| DOSPERT financial | 15.4 | 17.6 | ** | 16.3 | 16.4 | n.s. | 16.2 | 16.6 | n.s. |
| # of subjects | 180 | 128 | | 171 | 137 | | 192 | 116 | |

Note: n.s. is for not significant; *** p<0.01, ** p<0.05, * p<0.10. Due to missing observations on income, means are computed from 121 observations in the group of non-skewness seekers and 174 observations in the group of skewness-seekers for the first pairwise comparison. The corresponding numbers are 131 and 164 for the second pairwise comparison, and 110 and 185 for the third pairwise comparison.

We repeat the same exercise for subjects classified as risk avoiders versus non-risk avoiders (vertical comparison of lotteries), with the results reported in Table 7. The results show that risk avoiders are, on average, older, more likely to be female, and less educated. Also, the average risk-taking score and DOSPERT index are consistent with expectations in the sense that non-risk avoiders exhibit higher risk-taking scores on average and higher global DOSPERT measures, than risk avoiders. These findings suggest that preferences for risk-taking as elicited from the survey (self-assessment of risk-taking behavior and DOSPERT scores) correlate with subjects' revealed preferences when faced with the lotteries. In addition, the fact that older and less educated subjects are more likely to be both skewness seekers and risk avoiders, corresponds with the significant positive correlation we found above between the two behaviors.

**Table 7. Comparisons of characteristics between risk avoiders and non-risk avoiders**

| | Lottery F vs Lottery C | | | Lottery D vs Lottery A | | | Lottery E vs Lottery B | | |
|---|---|---|---|---|---|---|---|---|---|
| | risk avoiders | non-risk avoiders | sig. | risk avoiders | non- risk avoiders | sig. | risk avoiders | non- risk avoiders | sig. |
| Age | 41.7 | 38.6 | ** | 41.9 | 38.8 | ** | 41.2 | 39.1 | n.s. |
| Subject is a male (0/1) | 0.54 | 0.58 | n.s. | 0.50 | 0.61 | ** | 0.47 | 0.66 | *** |
| Higher education (0/1) | 0.68 | 0.81 | ** | 0.68 | 0.80 | ** | 0.72 | 0.77 | n.s. |
| Income (€) | 1,707 | 1,851 | n.s. | 1,631 | 1,899 | ** | 1,722 | 1,838 | n.s. |
| Executives (0/1) | 0.14 | 0.24 | ** | 0.09 | 0.26 | *** | 0.19 | 0.18 | n.s. |
| Risk-taking score | 3.81 | 4.80 | *** | 3.81 | 4.70 | *** | 3.80 | 4.82 | *** |
| DOSPERT global | 94.9 | 101.0 | ** | 95.0 | 100.3 | * | 93.2 | 102.8 | *** |
| DOSPERT recreational | 18.3 | 20.3 | * | 18.2 | 20.2 | * | 17.9 | 20.7 | *** |
| DOSPERT financial | 15.3 | 17.4 | ** | 15.8 | 16.8 | n.s. | 14.8 | 18.0 | *** |
| # of subjects | 155 | 153 | | 138 | 170 | | 157 | 151 | |

Note: n.s. is for not significant; *** p<0.01, ** p<0.05, * p<0.10. Non-risk avoiders include both risk-neutral and risk-seeking subjects. Due to missing observations on income, means are computed from 151 observations in the group of risk avoiders and 144 observations in the group of non-risk avoiders for the first pairwise comparison. The corresponding numbers are 134 and 161 for the second pairwise comparison, and 154 and 141 for the third pairwise comparison.

## 4. Regression analysis of the experimental results

We first study how subject's choices as measured by the elicited CE depend on lottery characteristics (here, their second and third moments). Regression analysis is used to confirm results from the descriptive analysis showing higher CEs for positively skewed lotteries and for lotteries with smaller variances. The benchmark model features the individual CE for subject *i* and lottery *t* (*t* = A, B, C, D, E, F) as the dependent variable. Explanatory factors include the variance and skewness of the lottery (the two direct effects and their interaction) along with individual-specific effects assumed to be random. Each subject makes six choices. The intercept of the model is individual-specific but the slope is assumed constant over individuals and lotteries. The model is as follows with $u_{it}$ the error term assumed to be independent and identically distributed:

$$CE_{it} = \alpha_i + \beta_{var}.var_t + \beta_{sk}.skew_t + \beta_{var \times sk}.var_t.skew_t + u_{it} \quad (1)$$

The estimation is run on a total of 1,848 observations, corresponding to 308 subjects each making six choices. We estimate two versions of the model in Eq. (1). First, in model (1), we consider only the direct effects of variance and skewness (i.e., we assume $\beta_{var \times sk} = 0$). Second, we add the interaction term between the two moments (models (2) to (5)) with and without control variables (risk preferences and socio-demographics). Due to missing observations, the models including income are run on a total of 1,770 observations, corresponding to 295 subjects each making six choices. Each random-effect model is estimated using Generalized Least Squares (GLS).[15] Results are shown in Table 8.

[15] We also controlled for the order of presentation of the six lotteries. Results remained unchanged.

**Table 8. GLS estimation of CE as a function of lottery characteristics**

| | Model w/o interaction term | Models w/ interaction term | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | | (4) | (5) | |
| | | | (a) | (b) | | (a) | (b) |
| | Coef (Std Error) | Coef (Std Error) | Coef (Std Error) | Coef (Std Error) | Coef (Std Error) | Coef (Std Error) | Coef (Std Error) |
| Variance | -0.004*** | -0.004*** | -0.004*** | -0.004*** | -0.004*** | -0.004*** | -0.004*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Skewness | 5.902*** | 5.237*** | 5.237*** | 5.237*** | 5.474*** | 5.474*** | 5.474*** |
| | (0.428) | (1.117) | (1.117) | (1.117) | (1.134) | (1.134) | (1.134) |
| Var x Skewness | – | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Risk preference | – | – | 2.525*** | 2.259*** | – | 2.310*** | 1.651** |
| | | | (0.388) | (0.706) | | (0.401) | (0.766) |
| Subject is male (0/1) | – | – | – | – | 4.659** | 3.079 | 3.726** |
| | | | | | (2.037) | (1.952) | (2.070) |
| Subject's age | – | – | – | – | -0.186** | -0.134* | -0.137 |
| | | | | | (0.083) | (0.079) | (0.085) |
| Higher education (0/1) | – | – | – | – | -0.059 | 0.295 | -0.052 |
| | | | | | (2.453) | (2.328) | (2.438) |
| Executive occ. (0/1) | – | – | – | – | 6.017** | 6.082** | 6.061** |
| | | | | | (2.853) | (2.706) | (2.835) |
| Log income | – | – | – | – | 0.847 | -0.227 | 0.807 |
| | | | | | (1.821) | (1.737) | (1.810) |
| Constant | 71.625*** | 71.625*** | 60.765*** | 62.299*** | 69.003*** | 65.592*** | 61.004*** |
| | (1.199) | (1.199) | (2.028) | (3.147) | (12.692) | (12.056) | (13.147) |
| # of obs. | 1,848 | 1,848 | 1,848 | 1,848 | 1,770 | 1,770 | 1,770 |
| # of subjects | 308 | 308 | 308 | 308 | 295 | 295 | 295 |
| R-sq. overall | 0.0379 | 0.0380 | 0.1207 | 0.0600 | 0.0838 | 0.1500 | 0.0940 |

Notes: In models (a), the risk preference variable is the general risk-taking score while in models (b), it is the global DOSPERT score; *** p<0.01, ** p<0.05, * p<0.10.

The two models produce comparable estimates for the direct effect of variance and skewness, confirming that subjects value lotteries that have a smaller variance or a larger skewness more. The interaction term between variance and skewness is not found statistically significant. The expected change in CE following a change in lottery variance and skewness is rather moderate and in line with what was shown on Figure 2: considering two lotteries with identical skewness, the estimated coefficients in the model without interaction imply that moving from a small variance to a high variance lottery leads to a decrease in CE by around €2.50 (around 4% of the average elicited CE).[16] Similarly, when considering two lotteries with identical variance, a 0.8 increase in skewness (from -0.8 to 0 or from 0 to 0.8) induces an average increase in CE estimated at €4.72 (around 7% of the average CE).[17]

We add control variables in models (3) to (5). We find that the estimated parameters for the variables associated with the moments are unchanged. The model with the highest fit is model (5a) (overall R-squared is 0.15) where both the risk-taking score and socio-demographics are included.[18] The control that has the largest impact on the overall R-squared is the risk-taking score. Socio-demographics contribute less. When comparing the two proxies for risk preferences, we find that the global DOSPERT has a lower explanatory power.[19] Finally, the models with control variables show that the CE is higher for those who are willing to take more risks, for younger subjects, for those having executive occupation and for males (coefficient not significant in one model only). These individuals value playing lotteries more, which is in line with findings from the risk preference literature using lottery choices.

Next, we investigate whether there is heterogeneity in the valuation of lottery variance and skewness with respect to subjects' self-assessment of risk attitudes (risk-taking score) and DOSPERT scores (both the global score and recreational- and financial-specific scores). We distinguish between subjects for which the risk-taking score is below the median (mostly risk-averse subjects), and those for which it is above (mostly risk takers). We also test if the

[16] The expected change in CE moving from a lottery with standard deviation equal to 20 to a lottery with standard deviation equal to 32 is computed as follows: -0.004*(32*32 – 20*20)=-2.496.

[17] We checked if these relatively small changes in CE might have resulted from subjects not paying much attention. We ran the analysis excluding those subjects whose decision time fell in the lowest or in the highest quartile, and results remain unchanged. We also did not observe any specific tendency to select the middle row when subjects had to choose between the lottery and the sure amount.

[18] The overall R-squared is rather low in the two main models (1) and (2), just below 0.04. However, this is comparable to other similar experiments such as Noussair et al. (2014).

[19] The results are unchanged if we use the recreational- and financial-DOSPERT specific scores instead. Results are not shown here but are available upon request.

coefficients vary between subjects depending on how their scores computed from the DOSPERT questionnaire compare to the sample median. Results are shown in Table 9.

**Table 9. GLS estimation of CE as a function of lottery characteristics for different groups of subjects**

| | **Risk-taking score < = median** | **Risk-taking score > median** | **Global DOSPERT < = median** | **Global DOSPERT > median** |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Coef (Std Error) | Coef (Std Error) | Coef (Std Error) | Coef (Std Error) |
| Variance | -0.007*** | -0.001 | -0.005*** | -0.003** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Skewness | 4.263*** | 6.212*** | 5.500*** | 4.978*** |
| | (1.450) | (1.689) | (1.527) | (1.630) |
| Var X Skewness | 0.003* | -0.001 | 0.001 | 0.001 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Constant | 69.101*** | 74.149*** | 70.360*** | 72.873*** |
| | (1.782) | (1.521) | (1.808) | (1.566) |
| # of obs. | 924 | 924 | 918 | 930 |
| # of subjects | 154 | 154 | 153 | 155 |
| R-sq. overall | 0.0478 | 0.0347 | 0.0387 | 0.0388 |

Notes: *** p<0.01, ** p<0.05, * p<0.10.

We observe some heterogeneity in subjects' valuation of variance and skewness depending on their self-assessed risk attitudes. Subjects who are characterized by a risk-taking score which is lower than the median, value lotteries with a higher variance significantly less (model (1)). On the contrary, the lottery variance does not matter for subjects who are characterized by a risk-taking score which is higher than the median (model (2)). For both groups, lotteries with a larger skewness are valued more. The coefficient of the skewness component is not statistically different between the two groups (i.e., the two 95% confidence intervals overlap). The interaction between variance and skewness is significant (at the 10% level) only for those individuals who are willing to take less risk than the median subject. The coefficient of the interaction term is positive indicating that the valuation of a lottery with positive skewness is higher for lotteries having high variance. When subjects are classified based on their global DOSPERT measure, the variance component remains significant at the 5% level for those exhibiting a global DOSPERT which is higher than the median subject. The interaction term is not found significant in either model (3) or (4). These findings show significant heterogeneity in behavior and valuation of second and third moments of the lotteries as well as some differences in variance and skewness significance depending on which self-assessed risk attitude measure is used.[20]

To investigate further the heterogeneity in risk taking and skewness seeking behavior, we run regressions on the number of risk avoiding choices (from Figure 4) and the number of skewness seeking choices (from Figure 6) on subjects' characteristics. To avoid multicollinearity problems, we include in separate models the risk-taking score and DOSPERT global, financial, and recreational measures. OLS estimation results are shown in Tables 10 and 11.

The number of risk avoiding choices (Table 10) is primarily explained by subjects' gender and self-assessed risk measures. In model (1) where self-assessed risk measures are not included, age and gender are the only characteristics that are statistically significant, indicating that older subjects and female subjects make more risk avoiding choices. These results contrast with those in Table 7 where our comparison of the average characteristics of risk avoiders versus non risk avoiders revealed some additional significant differences in education and

[20] Replacing the DOSPERT global score with either the DOSPERT recreational or financial score generates estimated coefficients that are not statistically different from those shown in columns (3) and (4) of Table 9. However, the coefficient on the lottery variance is no longer significant for subjects taking more risk (in both domains) than the median subject. This finding suggests that, for this particular experiment, the recreational and financial DOSPERT scores are more in line with the self-assessed general risk-attitude than the DOSPERT global score.

occupation, although none were consistently significant across all three lottery comparisons. In models (2) to (5), male subjects and subjects who consider themselves as taking more risk, make fewer risk avoiding choices, although the effect of gender is only weakly significant. The risk-taking score has a stronger significance than any of the three DOSPERT measures. Results from models (2) to (5) suggest that the impact of age is captured by the risk measures (see later for further discussion and evidence).

**Table 10. OLS estimation of the number of risk avoiding choices on subjects' characteristics**

| | Coef. | Coef. | Coef. | Coef. | Coef. |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Subject's age | 0.011** | 0.008 | 0.008 | 0.009 | 0.008 |
| Subject is male (0/1) | -0.302** | -0.228* | -0.238* | -0.241* | -0.250* |
| Higher educ (0/1) | -0.239 | -0.256* | -0.240 | -0.249 | -0.252 |
| Log income | -0.136 | -0.085 | -0.133 | -0.120 | -0.134 |
| Executive occ. (0/1) | -0.240 | -0.243 | -0.243 | -0.240 | -0.228 |
| Risk-taking score | - | -0.108*** | - | - | - |
| Global DOSPERT | - | - | -0.006* | - | - |
| Financial DOSPERT | - | - | - | -0.018** | - |
| Rec. DOSPERT | - | - | - | - | -0.013* |
| Constant | 2.435*** | 2.595*** | 3.093*** | 2.681*** | 2.777*** |
| Number of obs. | 295 | 295 | 295 | 295 | 295 |
| Adjusted R-sq | 0.0586 | 0.1070 | 0.0722 | 0.0700 | 0.0658 |

*** p<0.01, ** p<0.05, * p<0.10

On the contrary, gender is not a significant determinant of skewness seeking choices (it is found weakly significant only in model (1)), but age, education, and occupation are significant (Table 11). Older, less educated subjects, and those who are not in an executive occupation make more skewness seeking choices on average. Subjects who exhibit a higher risk-taking score also make fewer skewness seeking choices. The DOSPERT measures are not found to be significant. These results are consistent with our earlier analysis that compared the average characteristics of skewness seekers versus non skewness seekers (as reported in Tables 5 and 6), as well as the significant positive correlation we found between risk avoidance and skewness seeking choices.

**Table 11. OLS estimation of the number of skewness seeking choices on subjects' characteristics**

| | Coef. | Coef. | Coef. | Coef. | Coef. |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Subject's age | 0.034*** | 0.030*** | 0.031*** | 0.031*** | 0.030*** |
| Subject is male (0/1) | -0.387* | -0.280 | -0.328 | -0.326 | -0.329 |
| Higher education (0/1) | -0.593** | -0.617** | -0.593** | -0.602** | -0.608** |
| Log income | -0.263 | -0.191 | -0.261 | -0.248 | -0.261 |
| Executive occ. (0/1) | -0.664** | -0.669** | -0.667** | -0.665** | -0.651** |
| Risk-taking score | - | -0.156*** | - | - | - |
| Global DOSPERT | - | - | -0.005 | - | - |
| Financial DOSPERT | - | - | - | -0.018 | - |
| Recreational DOSPERT | - | - | - | - | -0.015 |
| Constant | 4.971*** | 5.202*** | 5.578*** | 5.217*** | 5.351*** |
| Number of obs. | 295 | 295 | 295 | 295 | 295 |
| Adjusted R-sq | 0.1200 | 0.1519 | 0.1216 | 0.1217 | 0.1212 |

Note: n.s. is for not significant; *** p<0.01, ** p<0.05, * p<0.10.

Finally, we ran additional regressions along the lines of Dohmen et al. (2011) to assess the relationship between self-assessed risk attitudes and subjects' socio-demographic characteristics. We ran four regressions featuring the following four dependent variables: the risk-taking score, the global, recreational, and financial DOSPERT scores. Results are shown in Appendix E. The willingness to take risks as measured by the four self-assessed scores is found to be higher for males and to decrease with age, as in Dohmen et al. (2011, Table 1). Whether the respondent has reached a higher education level and whether he/she is working as an executive or has a senior intellectual occupation are not found significant in any of the four models. Subjects' income is found significant (at the 10% level) only in the first model, indicating that wealthier subjects are willing to take more risks in general, as measured by the self-assessed risk-taking score.

These results further our interpretation of the results in Table 11. Specifically, while gender does not directly impact on skewness seeking behavior, male subjects have a higher risk-taking score, and correspondingly make fewer skewness seeking choices. Age, however, seems to operate through two channels. First, older subjects take fewer risks leading to more skewness seeking. However, there is also a direct effect of age. Finally, education and occupation do not impact risk avoiding behavior only skewness seeking behavior, with both more educated people and those in senior intellectual occupations less likely to exhibit skewness seeking behavior. Older and female subjects therefore are more likely to exhibit both risk avoiding and skewness seeking behavior.

## 5. Discussion

Our main contribution is to measure risk taking and skewness seeking behavior and the interaction between them in a diverse population. We find that the most common behavior is risk avoidance and skewness seeking, but on average there is no interaction between the two. That is, skewness seeking is not affected by the variance of the lotteries involved, nor is risk taking affected by the skewness of the lotteries. While risk avoidance has been documented in diverse populations, skewness seeking (as compared to prudence) has not. Further, our average finding of no interaction effect contrasts with the common finding of a positive interaction effect in lab experiments and reinforces the need to study broader populations.

Despite consistent aggregate level findings, we also observe considerable heterogeneity in both skewness seeking and risk avoiding behavior, some of which is correlated with individual characteristics. In particular, we observe that skewness-seekers are older, less educated, and less likely to have an executive or high intellectual occupation than non skewness-seekers. Those with a lower risk-taking score also make more skewness seeking choices. That is, we observe a significant positive correlation between risk avoidance and skewness seeking behavior. Further, we find a weakly significant positive interaction effect among those who were more risk avoiding (as measured by those whose general risk-taking score is below the median). This segment of our sample values skewed lotteries more when the variance is higher, and higher variance lotteries higher when the skewness is higher.

Our results also contribute to evidence regarding risk taking behavior among a broader population. First, based on experimental choices, we found that risk avoiders are more likely to be older, female, less educated, and less likely to be in an executive role than non- risk avoiders. Second, based on our survey measures, we found that both females and older subjects are less willing to take risk, while no other characteristics were correlated. This finding is consistent for both the risk-taking score and the DOSPERT measures, and the same as reported by Dohmen et al. (2011).

Finally, our results also add to the literature on the correlation between survey-based and experimental measures of risk preferences. We find that the general risk-taking score measure was very informative, with the DOSPERT measures less so. From Table 7 we find that while all measures correlated with risk avoiding choices, the risk-taking score was more consistent and strongly significant. The regressions in Table 8 confirm that these measures remain useful even after controlling for socio-demographics, with the general risk-taking score strongly significant. The risk-taking score is also strongly associated with the number of skewness seeking choices, as seen in Table 11, whereas none of the DOSPERT measures were. Thus, similar to Dohmen et al. (2011), who also elicit CEs, we show the validity of these survey measures, particularly the simple risk-taking measure, in predicting behavior in an incentivized lottery task.[21]

## 6. Conclusion

Our findings validate the importance of verifying lab findings in more diverse populations. Specifically, while lab studies tend to find a positive interaction effect, so that subjects are more willing to take on risk as the skewness of the lottery increases, we instead find no interaction effect on average, and a (weakly significant) positive interaction effect in only a subset of the population that is especially risk avoiding. We also find that skewness seeking was unaffected by the variance of the lotteries involved. The implications are quite different. For example, a zero interaction effect implies that people are no more likely to buy insurance as the skewness of the options either increases or decreases. In contrast, a positive interaction effect implies that people are more likely to buy insurance as outcomes become more left-skewed (i.e., less skewed). Many important risks faced by individuals are left-skewed such as health and employment outcomes, and investments in financial markets, where there is a small chance of a very poor outcome occurring. The threat of climate change, as well as greater global connectivity increases the importance of these left-skewed risks.

Our results further highlight how a positive interaction effect may be present only among certain segments of the population - in our experiment, these were the most risk

[21] While Dohmen et al. (2011) found domain specific measures (although much simpler than DOSPERT) predictive, Deck et al. (2013) instead found that domain specific risk attitudes didn't explain variation in experimental measures of risk preferences. Crosetto and Filippin (2016) also find weak connection to actual tasks noting low explanatory power (R-squared).

avoiding who also tended to be the most skewness seeking. Such people are more likely to take on risks that they like more, which in their case are more right-skewed. Demographically this segment of the population tends to be older and female. In addition, less educated segments tend to be more skewness seeking. Since education matters, then the labor market studies that focus on college graduates and superstars (Flyer, 1997; Grove et al., 2021; Choi et al., 2021) might not tell the whole story compared to a broader range of participants. Also, demographic differences in skewness seeking itself might become more important due to climate change and financial market linkages revealing vulnerabilities and potentially exacerbating inequities. Finally, the implications of the tradeoff between variance and skewness are particularly important in agriculture where crop yields from adopting new technologies and from climate risk typically affect all the moments of the distribution (Chavas and Shi 2015, Emerick et al. 2016). Our results demonstrate the importance of extrapolating from population-specific findings when applying these results to specific settings.

On the other hand, although our sample is more diverse than a standard lab sample, we acknowledge that it is not representative of the French population as our subjects are younger and more educated than the general French population. Similarly, while our stakes were considerably higher than in many lab-based studies, the magnitudes are still smaller than in many real-world scenarios. This might explain why our estimated effect sizes for variance and skewness were small even if strongly significant. On the other hand, Astebro et al. (2015) found that while increased stakes lead to less risk taking, it had no effect on how skewness affected risk taking for either students or executives. Similarly, Haering et al. (2020) found that a ten-fold increase in stakes did not affect prudence in their lab experiment with Chinese subjects.

Even if the design of the six lotteries, particularly the expected monetary gain, was constrained by the available budget, the chosen skewness (of magnitude 0.8) is in the range of what is observed in the real world. In their study of firm returns in the US industry, Choi et al.

(2021) report a median annual skewness of 0.86. In the agricultural sector, crop yield distributions described in Babcock (2015) are characterized by a skewness that varies between 0.05 and 0.62 in magnitude.[22]

Finally, for a clean design, we focused on only lotteries involving gains, yet many important real-world examples, such insurance, climate risk, and health decisions involve losses, often of a substantial magnitude. Bleichrodt and van Bruggen (2020) find very different preferences over lotteries involving only losses compared to only gains. Specifically, while risk aversion and prudence are the modal preferences for lotteries involving only gains, this switches to risk loving and imprudent choices for lotteries involving only losses. Relatedly, studies that use mixed lotteries (Grossman and Eckel, 2015; Bougherara et al., 2021) find varying results. Bougherara et al., (2021), for example, find the most common behavior is skewness avoidance and risk taking, while Taylor (2021) shows how loss aversion accounts for at least some of the positive interaction effect found in Grossman and Eckel (2015). Given the importance of losses in real-world examples, it is crucial to understand examples such as these in future work.

Further work should also seek to explain the heterogeneity in behavior and link it to underlying theoretical models. Several recent papers provide different explanations. Dertwinkel-Kalt and Koster (2020) provide experimental evidence that salience (in particular, the contrast effect) can explain skewness preferences. On the other hand, Bayrak and Hey (2020) develop an alternative model of risky choices, where the skewness of the outcomes, lottery dispersion, and individual optimism all explicitly enter the decision-making process. They provide experimental evidence that their new model outperforms other common models including salience theory. A third perspective is given by Bougherara et al. (2021) who find a

[22] In Babcock (2015), crop yields are assumed to follow a Beta distribution. The skewness of the three crop yield distributions is not reported by the author, but it can be computed from the shape parameters shown at the bottom of Table 1.

link between skewness avoiding behavior and probability weighting at the individual level. Unifying these disparate findings and models should be a top priority for future work.

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# Appendix A

## Experimental Instructions (Translated from French)

This survey is part of a public research project supported by INRAE, the French National Research Institute for Agriculture, Food and Environment (www.inrae.fr/en).

The main purpose of this survey is to better understand how individuals make their decisions when facing uncertainty. The outcome of this survey will only be used for public research purposes.

At the end of the survey, 15 persons (among the 308 participants) will be selected at random and will receive a payment which depends on their decisions in the survey.

It is important that you be careful to: i) not be disturbed when answering the survey; ii) not do other things while answering the survey (such as navigating on the internet) and, iii) answer the survey on your own, without the help of anyone.

The survey will be anonymous. The scientists involved in this research project will not be able to make any link between your identity and your responses. The other survey participants will not be able to identify you and you won’t be able to identify them.

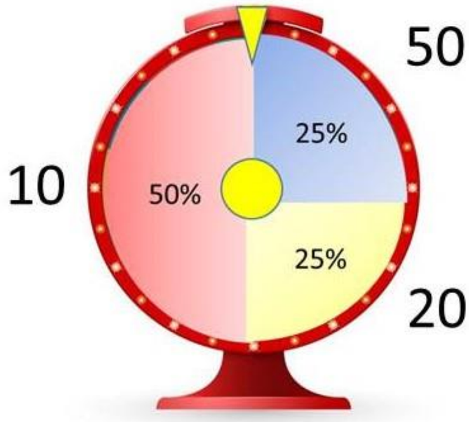
The survey will be divided in two parts. In Part I, you will be able to win some amount of money depending on your decisions. In Part II, you will be asked to fill a short questionnaire.

**Part I**

In this part, you will be asked to choose repeatedly between a fixed amount of money and a lottery. The lottery will always give you a chance to win one of three amounts of money (a first given amount with 50% chance of winning, a second given amount with 25% chance, and a third given amount with 25% chance).

Figure A-1 shows a typical choice task.

Figure A-1: Example of a typical decision task

| **Lottery (amounts and % chance)** | **Sure amount** | **I prefer:** |
|---|---|---|
|  | 10 | □ The lottery □ The sure amount |
| | 15 | □ The lottery □ The sure amount |
| | 20 | □ The lottery □ The sure amount |
| | 25 | □ The lottery □ The sure amount |
| | 30 | □ The lottery □ The sure amount |
| | 35 | □ The lottery □ The sure amount |
| | 40 | □ The lottery □ The sure amount |
| | 45 | □ The lottery □ The sure amount |
| | 50 | □ The lottery □ The sure amount |

Let’s comment on this EXAMPLE. In this lottery, you have 50% chance of receiving 10, 25% chance of receiving 50 and 25% chance of receiving 20. For each row, you are asked to indicate whether you would prefer to play the lottery or to obtain the sure amount of money by ticking the preferred option.

We are interested in the amount for which you will switch from preferring the lottery to preferring the sure amount. Most likely, you will begin by choosing the lottery for small sure amounts, and at a certain point switch to the sure amount as the latter increases. If you do not want the lottery at all, you can choose to get the sure amount in the first row and then continue with the sure amount for all choices (if you prefer receiving 10 with certainty over the lottery you should also prefer getting 15 over the lottery, etc.). Where you will switch from the lottery to the sure amount depends entirely on your preferences—there are no right or wrong answers. You are allowed to switch only once.

THE ABOVE WAS JUST AN EXAMPLE. The decision tasks that you will face in Part I will be based on different values for the lottery outcomes and the sure amounts. You will be asked to undertake 6 decision tasks as the one shown in the example.

At the end of Part I and if you are among the 15 persons randomly selected for receiving a payment, then one of the 6 decision tasks will be chosen at random. Then for this decision task one row, corresponding to one of your decisions to choose between the sure amount and the lottery, will be drawn randomly. If for the selected row you had preferred the sure amount to the lottery, then your payment will be equal to this sure amount. If for the selected row you had chosen the lottery instead of the sure amount, then the lottery will be played and your payment will be equal to the outcome of the lottery.

**Part II - Questionnaire**

*a. Self-assessment of risk attitudes*

Some people like to take risks while others are more reluctant. How would you rate your attitude towards risk taking in general? Choose a number on a scale from 0 (not at all willing to take risks) to 10 (very willing to take risks).

*b. DOSPERT questionnaire - Domain-specific risk-taking scale*

For each of the following statements, please indicate the likelihood that you would engage in the described activity or behaviour if you were to find yourself in that situation. Provide a rating from Extremely Unlikely to Extremely Likely, using the following scale:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Extremely Unlikely | Moderately Unlikely | Somewhat Unlikely | Not Sure | Somewhat Likely | Moderately Likely | Extremely Likely |

1. Admitting that your tastes are different from those of a friend. (S)
2. Going camping in the wilderness. (R)
3. Betting a day's income at the horse races. (F/G)
4. Investing 10% of your annual income in a moderate growth diversified fund. (F/I)
5. Drinking heavily at a social function. (H/S)
6. Taking some questionable deductions on your income tax return. (E)
7. Disagreeing with an authority figure on a major issue. (S)
8. Betting a day's income at a high-stake poker game. (F/G)
9. Having an affair with a married man/woman. (E)
10. Passing off somebody else's work as your own. (E)
11. Going down a ski run that is beyond your ability. (R)
12. Investing 5% of your annual income in a very speculative stock. (F/I)
13. Going whitewater rafting at high water in the spring. (R)
14. Betting a day's income on the outcome of a sporting event (F/G)
15. Engaging in unprotected sex. (H/S)
16. Revealing a friend's secret to someone else. (E)
17. Driving a car without wearing a seat belt. (H/S)
18. Investing 10% of your annual income in a new business venture. (F/I)
19. Taking a skydiving class. (R)
20. Riding a motorcycle without a helmet. (H/S)
21. Choosing a career that you truly enjoy over a more secure one. (S)
22. Speaking your mind about an unpopular issue in a meeting at work. (S)
23. Sunbathing without sunscreen. (H/S)
24. Bungee jumping off a tall bridge. (R)
25. Piloting a small plane. (R)
26. Walking home alone at night in an unsafe area of town. (H/S)

27. Moving to a city far away from your extended family. (S)
28. Starting a new career in your mid-thirties. (S)
29. Leaving your young children alone at home while running an errand. (E)
30. Not returning a wallet you found that contains $200. (E)

Note. E = Ethical, F = Financial, H/S = Health/Safety, R = Recreational, and S = Social.

*c. Socio-demographic questionnaire*

Age:

Gender: □ male □ female

What is your highest education level? [coded from 7 to 0]
□ *Bac +5 ou plus* [Master's degree or beyond]
□ *Bac +4* [Intermediate degree between bachelor's and master's degree]
□ *Bac +3 (Licence ou équivalent)* [Bachelor's degree]
□ *Bac +1/+2* [Baccalaureate + 1 or 2 years]
□ *Baccalauréat (général, technologique ou professionnel)* [General, technological or vocational baccalaureate; equivalent to US high-school diploma]
□ BEP, CAP or equivalent [BEP: Diploma of Occupational Studies, CAP: Certificate of Professional Aptitude]
□ *BEPC (brevet des collèges)* [certificate granted after completing the first four years of secondary education]
□ No training beyond *collèges* [*collèges*: first four years of secondary education from the ages of 11 to 15]

Individual monthly income before income tax:
□ Less than €1,100
□ Between €1,100 and €1,899
□ Between €1,900 and €2,299
□ Between €2,300 and €3,099
□ Between €3,100 and €3,999
□ Between €4,000 and €6,499
□ More than €6,500

What is your socio-professional category?
□ Farmers
□ Craftsmen, traders, company managers
□ Executives and higher intellectual occupations
□ Employees
□ Retired
□ Students
□ Unemployed

# Appendix B

## Representativeness of the sample

All national statistics were obtained from the website of INSEE (https://www.insee.fr/), the national statistics bureau of France. All the figures reported below are for the year 2020.

*Structure by sex and age*

In France in 2020, women represented 53% of the population of 20+ and men 47%. In the sample we have 44% women and 56% men. Our sample is also younger than the general French population. In our sample 77% of our subjects are aged between 20 and 50 while the corresponding proportion in France is 48%.

| **Age group** | **France (2020)** | | **Sample** | |
|---|---|---|---|---|
| | Female | Male | Female | Male |
| 20-29 | 7.3% | 7.4% | 8.8% | 14.6% |
| 30-39 | 8.3% | 7.8% | 12.3% | 16.9% |
| 40-49 | 8.5% | 8.2% | 13.0% | 11.7% |
| 50-59 | 8.8% | 8.4% | 7.8% | 6.8% |
| 60-69 | 8.2% | 7.4% | 1.6% | 4.2% |
| 70 + | 11.5% | 8.2% | 0.3% | 1.9% |
| **Total** | **52.6%** | **47.4%** | **43.8%** | **56.2%** |

*Education level by sex and age groups*

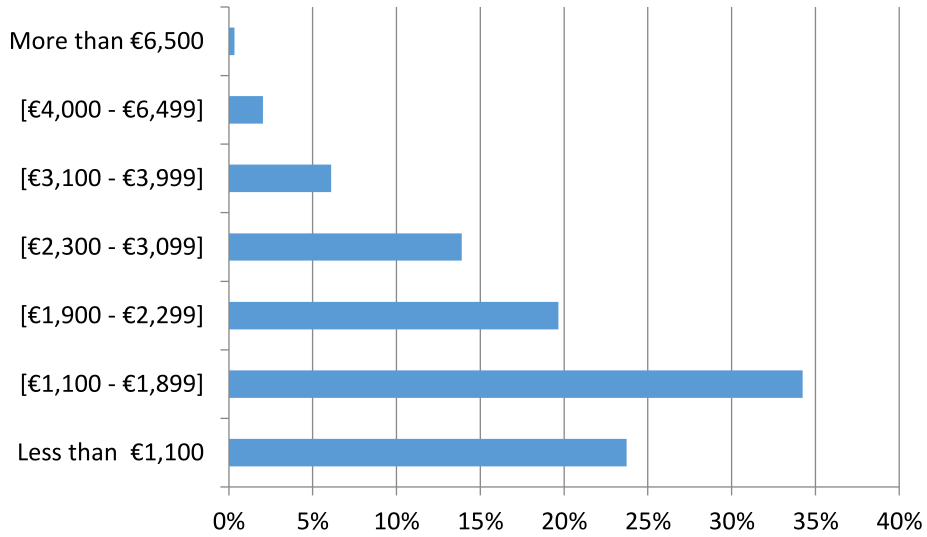
Percentage of population (by sex and age group) with *Baccalauréat* or higher diploma:

| Age group & gender | 25-34 | | 35-44 | | 45-54 | | 55-64 | |
|---|---|---|---|---|---|---|---|---|
| | Female | Male | Female | Male | Female | Male | Female | Male |
| France | 72.6 | 66.2 | 70.0 | 62.4 | 54.3 | 47.0 | 40.1 | 35.6 |
| Our sample | 90.9 | 96.4 | 88.9 | 90.9 | 85.3 | 87.5 | 86.7 | 83.3 |

Our sample is thus more educated than the French population, on average.

# Appendix C

## Distribution of individual monthly income in the sample (295 subjects)



# Appendix D

## Risk preference variables: means, standard deviations, and correlations

We report in the table below the mean and standard deviation (SD) of the risk-taking score and normalized DOSPERT measures for the 308 subjects. For comparison purposes, we standardize the DOSPERT variables on an 11-point scale: 0 (unwilling to take risks) to 10 (willing to take risks). The bottom of the table shows the correlation coefficients between the risk-taking score and DOSPERT items. All correlation coefficients are positive and statistically different from 0, as expected. The risk-taking score is moderately correlated with the global DOSPERT (correlation coefficient around 0.3) and has a slightly stronger correlation (around 0.4) with the DOSPERT score in social and financial-gambling domains. We note particularly high correlations between the DOSPERT scores in ethical and financial domains, in social and financial-investing domains, and in social and financial-gambling domains.

| | **Risk-taking score** | **Normalized DOSPERT measure** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ***Global*** | ***Ethical*** | ***Health*** | ***Recreational*** | ***Social*** | ***Financial*** | ***Financial Investing*** | **Financial Gambling** |
| **Mean** | 4.30 | 4.13 | 2.88 | 3.56 | 4.05 | 6.88 | 3.28 | 4.20 | 2.36 |
| **SD** | 2.39 | 1.38 | 1.63 | 1.97 | 2.40 | 1.74 | 2.06 | 2.50 | 2.46 |
| | | | | | | | | | |
| | **Risk-taking score** | ***Global*** | ***Ethical*** | ***Health*** | ***Recreational*** | ***Social*** | ***Financial*** | ***Financial Investing*** | **Financial Gambling** |
| **Risk-taking score** | 1 | | | | | | | | |
| **Global** | 0.3360*** | 1 | | | | | | | |
| **Ethical** | 0.1789*** | 0.6467*** | 1 | | | | | | |
| **Health** | 0.2724** | 0.7813*** | 0.3453*** | 1 | | | | | |
| **Recreational** | 0.1578*** | 0.5679*** | 0.1125*** | 0.3820*** | 1 | | | | |
| **Social** | 0.4103*** | 0.7107*** | 0.3756*** | 0.4293*** | 0.2170*** | 1 | | | |
| **Financial** | 0.1278*** | 0.7692*** | 0.5242*** | 0.4462*** | 0.3184*** | 0.4163*** | 1 | | |
| **Financial Investing** | 0.2999*** | 0.6041*** | 0.4174*** | 0.3172*** | 0.1056** | 0.8292*** | 0.4222*** | 1 | |
| **Financial Gambling** | 0.3822*** | 0.5786*** | 0.2089*** | 0.3965*** | 0.2544*** | 0.8345*** | 0.2714*** | 0.3840*** | 1 |

Notes: *** p<0.01, ** p<0.05, * p<0.10.

# Appendix E

## Self-assessed risk attitudes and socio-demographic characteristics

We follow Dohmen et al. (2011) and regress self-assessed risk attitudes (here the risk-taking score and the global, recreational, and financial DOSPERT scores) on socio-demographic characteristics. We consider a dummy variable equal to 1 if the subject is a male, and 0 otherwise; the subject's age, his/her education level (we use the dummy variable that takes the value 1 for higher education, and 0 otherwise), whether the subject's occupation falls within the category of executives and senior intellectual jobs, and a (continuous) proxy for his/her income (transformed into log). OLS estimation results are shown in the table below. Only 295 observations had non-missing observations for income.

**OLS estimation of self-assessed risk scores as a function of socio-demographic characteristics (N = 295)**

| | Risk taking score | | DOSPERT global | | DOSPERT recreational | | DOSPERT financial | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | sig. | Coef. | sig. | Coef. | sig. | Coef. | sig. |
| Subject is a male (0/1) | 0.684 | ** | 0.565 | *** | 1.008 | *** | 0.879 | *** |
| | (0.283) | | (0.155) | | (0.268) | | (0.234) | |
| Subject's age | -0.022 | * | -0.029 | *** | -0.056 | *** | -0.032 | *** |
| | (0.012) | | (0.006) | | (0.011) | | (0.010) | |
| Higher education (0/1) | -0.153 | n.s. | -0.004 | n.s. | -0.256 | n.s. | -0.136 | n.s. |
| | (0.341) | | (0.187) | | (0.323) | | (0.282) | |
| Executive occ. (0/1) | -0.028 | n.s. | -0.026 | n.s. | 0.235 | n.s. | -0.005 | n.s. |
| | (0.397) | | (0.218) | | (0.375) | | (0.328) | |
| Log income | 0.465 | * | 0.024 | n.s. | 0.036 | n.s. | 0.224 | n.s. |
| | (0.253) | | (0.139) | | (0.240) | | (0.209) | |
| Constant | 1.477 | n.s. | 4.844 | *** | 5.639 | *** | 2.518 | * |
| | (1.763) | | (0.967) | | (1.667) | | (1.456) | |
| Adjusted R-squared | 0.0311 | | 0.1071 | | 0.1246 | | 0.0762 | |
| Fisher-test p-value | 0.0145 | | 0.0000 | | 0.0000 | | 0.0000 | |

Note: Standardized DOSPERT scores have been used. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10. n.s. is for not significant.