Risk aversion, prudence and temperance : an experiment in gain and loss

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Abstract

In this paper, our aims are of three orders: i) to characterize the individuals' preferences towards risk, prudence and temperance in the gain and loss domain; ii) to analyze potential correlations between domains, for a given feature of preferences, and between features, for a given domain; iii) to identify potential determinants of these individual preferences. For that purpose, we conducted a lab experiment eliciting risk aversion, prudence and temperance in the two domains and collected information about individuals' characteristics. First, our results indicate that participants are risk averse, prudent and temperate in the gain domain while risk averse, imprudent and temperate in the loss domain. Second, we observed that risk aversion in the gain and loss domains is positively and significantly correlated. The same result applies for prudence and temperance. We also identified that behaviors in terms of risk aversion, prudence and temperance are all bilaterally correlated in the gain and loss domains, except for risk aversion and temperance in the gain domain. Finally, we found that the determinants of the individual's preferences generally depend on the domain and the feature..

Keywords: risk aversion, prudence, temperance, experiment, correlations, determinants.

JEL codes: C91, D81

1   Introduction

The importance of risk aversion is widely recognized nowadays among scholars who analyze individuals' decision-making. However, this concept sometimes only partially captures the drivers of individuals' choices under risk, giving rise to the development of the concept of prudence and, more recently, the concept of temperance.

The economic literature dealing with decision-making under risk defines these different concepts and highlights their roles in various contexts.

In the framework of the theory of expected utility introduced by Von Neumann and Morgenstern [42], Arrow [3] and Pratt [47] define a risk-averse individual as being characterized by a concave utility function ($u''(.) < 0$). Immediately after these seminal contributions, the role of risk aversion on insurance decisions was proven by Mossin [41] and then in other decision processes like prevention (Ehrlich and Becker [26]) or portfolio choices (Bertrand and Prigent [6]). The main conclusion of this literature is that greater risk aversion leads to lower risk-taking, and then to higher insurance demand, higher prevention and more portfolio diversification.

In 1990, Kimball [37] observed that in order to explain precautionary savings in an expected utility framework, the concept of risk aversion is not sufficient: he introduced the notion of prudence. A prudent individual is characterized by a positive third derivative of the utility function ($u'''(.) > 0$). Subsequently, Eeckhoudt and Kimball [23] proved the role of prudence on insurance decisions. They show that decreasing absolute risk aversion and decreasing absolute prudence are required to guarantee that a background risk will raise the optimal insurance demand against the main risk. Prudence has also been shown to be determinant in decisions related to prevention (Eeckhoudt and Gollier [22], Dionne and Li [16]) or portfolio optimization (Le Courtois [11]). For example, Dionne and Li [16] showed that prudence tends to reduce prevention because prudent agents favor the accumulation of wealth to face risk and then are reluctant to spend money *ex ante*.

More recently, in 1992, Kimball [38] introduced the notion of temperance: a temperate individual is characterized by a negative fourth derivative of the utility function ($u''''(.) < 0$). The role of temperance is highlighted in saving decisions (Eeckhoudt and Schlesinger [25]) or portfolio choices (Arrondel *et al.* [2]). More recently, Mayrhofer [40] has shown that prudent choices could also be driven by temperance (when background risks are skewed). Nevertheless, as underlined by Crainich *et al.* [12], while risk aversion and prudence are largely used, nowadays temperance is still little known and meets a certain skepticism.

In the light of this evidence, considerable literature has developed, mainly in experimental economics, in order to empirically measure these features of preference (among other issues), display potential links between them, and find what can explain them.

Many elicitation procedures have therefore been proposed to measure risk aversion (Harrison and Rutstrom [31], Charness *et al.* [9], Blavatskyy [7]). Traditionally, these procedures quantify the parameter of risk aversion through lottery choices (Holt and Laury [33], Eckel and Grossman [21], Tanaka *et al.* [50] among others). Measurement of the parameters of prudence and temperance is more recent. Ebert and Wiesen [19] or Noussair *et al.* [43] proposed two different procedures, also based on lottery choices, to elicit prudence and tem-

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perance. The main conclusion of this literature is that individuals are risk averse, prudent and temperate in the gain domain.

Another part of the literature focuses on the link between the three features of preferences, and also on the link between the gain and loss domains for one feature. The theoretical papers of Crainich *et al.* [13] showed that risk lovers are prudent. Few papers tackle this question from an empirical point of view, however. The experimental results of Tarazona-Gomez [51] indicated no correlation between risk aversion and prudence. Deck and Schlesinger [15] showed that subjects' choices are positively correlated between even orders and between odd orders, but uncorrelated between even and odd orders. Consequently, they obtained a positive correlation between risk aversion (2nd order) and temperance (4th order), prudence (3rd order) and edgy (5th order), etc. Remark that all these papers consider only the gain domain. As regard to the link between gain and loss domain for one feature, we find only papers focusing on risk aversion. The "reflection effect" is well-identified in the literature on risk aversion, *i.e.*, risk aversion in the gain domain and risk seeking in the loss one (Schoemaker [48]; Di Mauro and Maffioletti [39]; Chakravarty and Roy [8]). For instance, Schoemaker [48] conducted an experiment on 200 U.S. students and found that only 35% of the subjects exhibited the same risk attitude in the gain as in the loss domain, corresponding to a low degree of correlation. However, we find no study addressing a similar question for prudence and temperance.

Another research direction is to try to explain preferences by identifying some determinants. Jianakoplos and Bernasek [36], using U.S. sample data, observed that women are more risk averse than men. De Paola [45], based on survey data on Italian students, showed that women are more risk averse than men and more patient subjects are more risk averse, while high-ability students are less risk averse. She also found that the father's job mattered while the mother's did not. Dohmen *et al.* [17] conducted a survey and an experiment on the resident adult population of Germany. They observed that gender, age, height and parental background have a significant impact on the willingness to take risks. Other results indicate a significant impact on risk aversion for variables like gender (Eckel and Grossman [21], Powell and Ansic [46], Hersch [32]), ethnicity/race (Holt and Laury [33], Hersch [32]) or different demographic groups (Halek and Eisenhauer [29]). A very interesting article is proposed by Outreville [44] who reviewed the literature on the determinants of risk aversion in an insurance context. While for risk aversion, in the gain domain, some determinants are clearly identified in the literature, to our knowledge, they have not been identified in the loss domain (are they similar?) and no paper focuses on the determinants of prudence and temperance.

In this context, our research questions are the following: Are individuals risk averse, prudent and temperate in the gain and loss domains? Are the three features of preferences correlated in a given domain? Are the individual's preferences correlated between domains for a given feature? What are the determinants of individuals' preferences towards risk, prudence and temperance in both domains?

Our objective is to try to answer these questions. These answers may be interesting on a number of different levels. First, from a theoretical point of view, this paper provides an empirical test of the alternation in the signs of the derivatives of the utility function both in the gain and loss domains. Second, from a modeling point of view, it may be interesting

to have more precise information on the individual's preferences towards risk, prudence and temperance in order to make relevant hypotheses and calibrate the parameters of the model adequately. Third, better knowledge of the links between the three features of preference and also between domains may be helpful to design experiments. Depending on the results, it may be relevant (or not) to elicit individuals' preferences in both domains. Fourth, the analysis of the determinants may be helpful to improve the efficiency of some public policies. If older people, for instance, are less risk averse but more prudent than others, it could be valuable to offer them more profitable (and riskier) savings products. If less educated people are less risk averse than others (regardless of age), maybe road safety campaigns should be more focused on them (and not especially on young people). If, as shown by Courbage and Rey [10], more prudent people do less health prevention (in the sense of self-protection), then it is necessary to identify prudent people on the basis of their characteristics and target persuasive campaigns on them. More generally, knowing the role of age, gender or other individual characteristics linked to education or leisure on the three features of preferences may be very helpful to implement relevant public policy (subsidies, price support, taxes), to design contracts (insurance, working, health) or to propose innovations (financial products, portfolio optimization), etc.

Consequently, we propose to elicit individuals' risk aversion, prudence and temperance both in the gain and loss domains. For that purpose, we measure the individual's preferences through a lab experiment with students. We implement the recent procedure proposed by Noussair *et al.* [43] to elicit risk aversion, prudence and temperance in the gain domain, and we propose an extension of it to the loss domain. We analyze both the correlations between preferences in a given domain (for instance, risk aversion, prudence and temperance in the loss domain) and the correlation between the two domains (gain and loss) for each feature of preferences. Finally, we use real-life data about individuals' characteristics, obtained through a qualitative survey, to explain all these results.

Our results indicate that participants are mostly risk averse, prudent and temperate in the gain domain, while they are mostly risk averse, imprudent and temperate in the loss domain. We also observed that risk aversion in the gain and loss domains was positively and significantly correlated. The same result applies for prudence and temperance. We also showed that behaviors in terms of risk aversion, prudence and temperance were all bilaterally correlated in the gain and loss domains, except for risk aversion and temperance in the gain domain. Finally, we found that the determinants of the individual's preferences generally depend on the domain and the feature.

The rest of the paper is organized as follows. Section 2 presents the theoretical background of our experimental approach. Section 3 presents the experimental procedure and Section 4 the methodology. Section 5 presents the results and Section 6 concludes.

2 Theoretical background

As indicated in the introduction, risk aversion was defined by Arrow [3] and Pratt [47] as the concavity of the utility function ($u''(.) < 0$). This means that a (sufficiently) risk averse individual who has to choose between a first lottery characterized by an uncertain payoff and

a second lottery characterized by a sure but lower (expected) payoff, will prefer the second (sure) lottery. In other words, a risk-averse individual is willing to decrease her expected payoff to escape risk. The idea beyond risk aversion is the reluctance to take risk. Arrow [3] and Pratt [47] also proposed to measure the intensity of risk aversion through the absolute and relative risk aversion coefficients.

According to Kimball [37], "*The term prudence is meant to suggest the propensity to prepare and forearm oneself in the face of uncertainty*". When related to a consumption-saving decision under risk, prudence corresponds to the intensity of the precautionary saving motive, so that prudence may lead an agent to respond to a risk by accumulating more wealth. Kimball [37] also proposed a way of measuring the intensity of prudence through the absolute and relative prudence coefficients. Gollier [28] also proposed an interesting definition. He said that an agent is prudent "*if adding an uninsurable zero-mean risk to his future wealth raises his optimal saving*".

Following Kimball [38], a temperate agent "*desires to moderate total exposure to risk*". Then, he "*may respond to an unavoidable risk by reducing exposure to other risks even when the other risks are statistically independent of the first*".

Consequently, the first definitions and measurements of these three features of preferences were mainly focused on the relationship between these concepts and the characteristics of the individual's utility function (in the expected utility framework).

However, Eeckhoudt and Schlesinger [24] introduced behavioral definitions of prudence and temperance, using risk apportionment. A decision-maker who is prudent "*prefers to apportion an unavoidable zero-mean risk to a high wealth state, while a temperate decision-maker prefers to apportion two independent zero-mean risks across different states of nature*" (Ebert and van de Kuilen [18]). By doing so, they introduced model-free definitions of prudence and of temperance. When considering the possibility of facing two independent zero-mean risks, Eeckhoudt and Schlesinger [24] defined a temperate individual as a decision-maker who prefers to "*disaggregate two independent risks*" (p. 281) into different states of Nature, instead of concentrating them on the same lottery. Put differently, a temperate individual prefers a high probability of not too extreme results to a low probability of very extreme ones.

These definitions have allowed the emergence of model-free measurements of prudence and temperance, "*in the sense that they retain validity if expected utility theory fails descriptively*" (Ebert and van de Kuilen [18]). Noussair *et al.* [43] developed a unified and model-free approach to measure risk aversion, prudence and temperance in the gain domain. In the study at hand, we have adopted these model-free definitions of risk aversion, prudence and temperance. We used the elicitation procedure developed by Noussair *et al.* [43], and extended it to the domain of loss. By combining this elicitation procedure with an extensive qualitative survey, we sought to determine what drives such features of preference, and how they are interlinked or not.

3 The lab experiment

3.1 The measure of individual preferences[1]

The measurement of an individual's preferences was based on the model-free methodology proposed by Noussair *et al.* [43][2]. We considered the same choice tasks as in Noussair *et al.* [43] presented in Table 1.

Table 1: Choice tasks

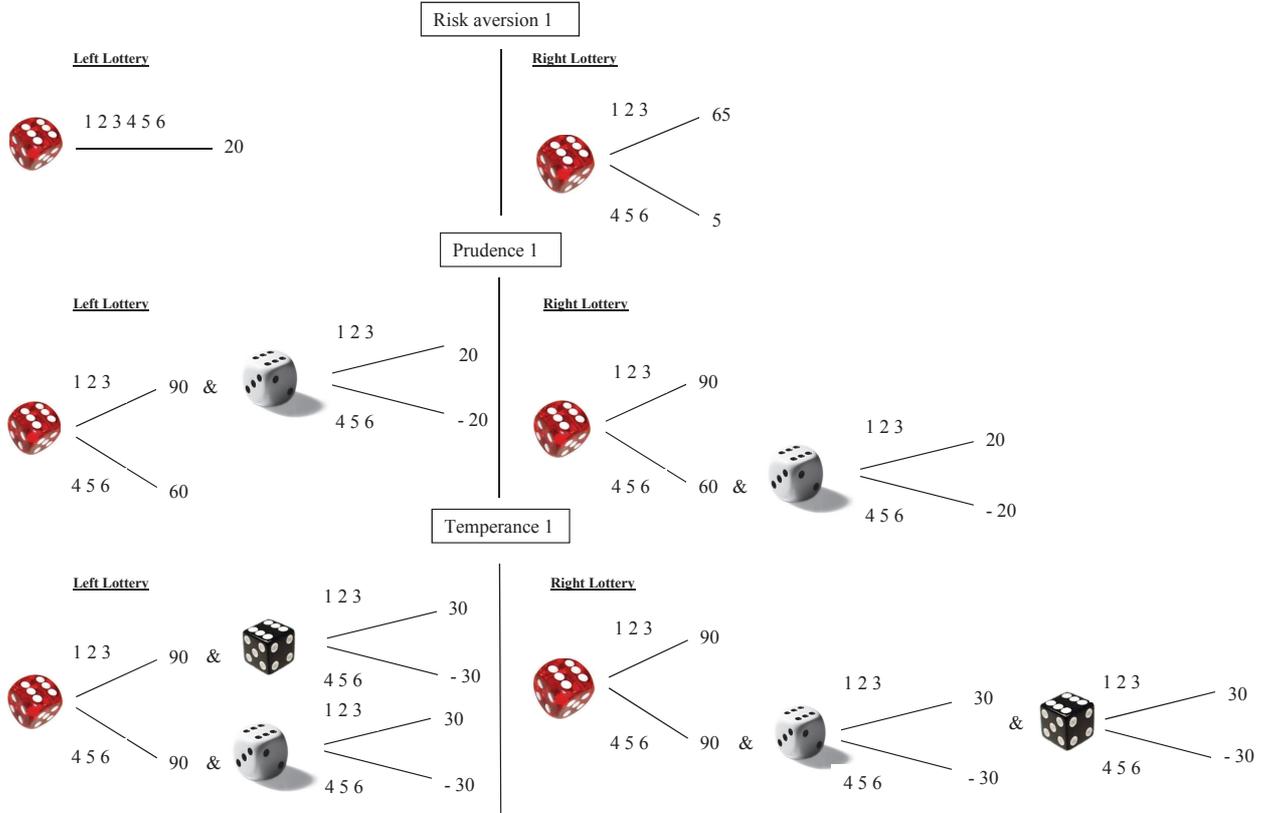|	Left Lottery	Right Lottery
Risk Aversion 1	20	[65_5]
Risk Aversion 2	25	[65_5]
Risk Aversion 3	30	[65_5]
Risk Aversion 4	35	[65_5]
Risk Aversion 5	40	[65_5]
Prudence 1	[(90+[20_-20])_60]	[90_(60+[20_-20])]
Prudence 2	[(90+[10_-10])_60]	[90_(60+[10_-10])]
Prudence 3	[(90+[40_-40])_60]	[90_(60+[40_-40])]
Prudence 4	[(135+[30_-30])_90]	[135_(90+[30_-30])]
Prudence 5	[(65+[20_-20])_35]	[65_(35+[20_-20])]
Temperance 1	[(90+[30_-30])_(90+[30_-30])]	[90_(90+[30_-30]+[30_-30])]
Temperance 2	[(90+[30_-30])_(90+[10_-10])]	[90_(90+[30_-30]+[10_-10])]
Temperance 3	[(90+[30_-30])_(90+[50_-50])]	[90_(90+[30_-30]+[50_-50])]
Temperance 4	[(30+[10_-10])_(30+[10_-10])]	[30_(30+[10_-10]+[10_-10])]
Temperance 5	[(70+[30_-30])_(70+[30_-30])]	[70_(70+[30_-30]+[30_-30])]

The subjects faced 15 lottery choices, five for risk aversion, five for prudence and five for temperance. We also extended this procedure to the loss domain, adding 15 supplementary lottery choices to each subject. For prudence and temperance the tasks were exactly the same as those presented in Table 1 but positive values became negative and vice versa. Concerning risk aversion, in the gain domain the decision-maker had to choose between a sure payoff and a lottery $\tilde{L} \equiv (50\%, 50\%; 5, 65)$ exhibiting an expected gain of 35. In the loss domain, the lottery exhibited an expected loss of -35, but we had to change the absolute value of the sure payoff, since risk aversion is measured through the willingness to accept a lower (but sure) payoff, instead of a higher expected (but riskier) outcome. We therefore chose sure payoffs from -30 to -50 (while sure payoffs in the gain domain ranged from 20 to 40). Each lottery was an equiprobable lottery with a 50% chance of each outcome occurring. The lotteries were presented as compound lotteries, and we used dice of different colors to highlight the independence of the risks (see Figure 1).

Figure 1 presents the first choice task for risk aversion, prudence and temperance in the gain domain. An example of a choice task in the loss domain is presented in Appendix A. In this Figure 1, and following Noussair *et al.* [43], the choice of the Left lottery indicates risk aversion, prudence, and temperance, respectively.

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[1]Note that this study is a part of a wider study proposed in Jacob *et al.* [35] so that the reader will sometimes be invited to refer to this paper for more details.

[2]See the Appendix C of Noussair *et al.* [43] for a comparison of the methods and findings of other existing studies trying to measure prudence and temperance.

Figure 1: Examples of choice tasks (gain domain)

In addition, Figure 1 highlights the definition of prudence and temperance proposed by Eeckhoudt and Schlesinger [24]. A prudent individual always chooses the Left lottery over the Right one because he prefers to associate a zero-mean risk with a good state of Nature rather than with a bad state. In the same vein, a temperate individual always selects the Left Lottery because he prefers to disaggregate two independent zero-mean risks across two states of Nature, rather than facing them in the same state. Consequently, the measure of the participant's risk aversion corresponds to the number of safe choices he made among the five decisions presented in Table 1. In the same vein, the measure of prudence (temperance) is equal to the number of prudent (temperate) choices made among the corresponding five decisions. The higher the number, the higher the strength of the individual's risk aversion / prudence / temperance[3]. Finally, subjects were presented with one lottery choice at a time, making a total of 30 choices for each participant.

During the experiment, the subjects always did the tasks in the same order: risk aversion, prudence and temperance, first in the gain domain and then in the loss domain.

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[3]The use of the number of binary decisions consistent with prudence and temperance, as measures of the strength of these attitudes, follows Deck and Schlesinger [14], Ebert and Wiesen [20] and Noussair *et al.* [43].

3.2 Individual characteristics

At the end of the experimental session, we asked the participants about their socio-demographic characteristics (age, gender, height, weight, nationality, religion) and socio-economic characteristics (leisure, parent's job, type of study, study level).

3.3 Participants and incentives

The experiment took place at the Laboratory of Experimental Economics of the University of Strasbourg (LEES) in November 2016. 246 students were recruited from different study programs (hard sciences, law, economics and management, sociology, literature). 12 sessions were run.

The experiment was incentivized. The subjects knew that at the end of the session, one task would be randomly drawn and that the associated decision would be implemented and paid. The payoffs were denominated in a fictitious currency called Experimental Currency Unit (ECU) and converted into euros at the end of the experiment at a rate known to the subjects (€1 euro = 15 ECUS). The payments of the subjects varied between €6 and €15 with an average of €9.92.

Note that a part of the experiment took place in the loss domain. In such a case, as is traditional, the subject had an endowment. This endowment was calculated and implemented so as to avoid the subjects suffering a real loss during the random selection of payment[4].

4 Methodology

To answer to our research questions, we combined both correlation and regression analyzes.

4.1 Correlation analysis

We wanted to analyze the correlation between individuals' preferences towards risk, prudence and temperance in a given domain, and also the correlation between domains for a given feature of preferences. Our data represent the number of safe, prudent and temperate choices and were then ordinal from 0 to 5. In this case, Agresti [1] and Howell [34] suggest using the correlation coefficient of Pearson. This coefficient is calculated as follows:

$$r = \frac{cov_{XY}}{S_X S_Y}$$

with cov_{XY} the covariance between the variables X and Y, and S_X and S_Y the standard deviation of X and Y respectively.

The coefficient r varies between -1 and 1. The closer the correlation coefficient to the extremes, the stronger the relation between the variables.

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[4]As mentioned above, this experiment was a part of a wider study (see Jacob *et al.* [35]). For this (part of the) experiment, the subjects were initially endowed with 150 ECUS. Adding a show-up fee of 5 euros ensured a positive final payoff.

In our context, variables X and Y represent either the gain and loss domain for one feature of preferences, or two different features of preferences for a given domain.

4.2 Regression analysis

We also wanted to characterize the determinants of risk aversion, prudence and temperance (3 features) in the gain and loss domains (2 domains), so we performed six different regressions. The dependent variables (number of safe, prudent and temperate choices) were ordinal, from 0 to 5. Consequently, we specified an ordered logit model. The model was the same for the six regressions. We describe below a generic equation, which is valid for all features and domains. The regression equation is:

$$y_i^* = X_i\beta + \epsilon_i$$

with y_i^* which stands for the strength of the i individual's preference feature under study (risk aversion, prudence or temperance), *i.e.* the number of safe / prudent / temperate choices (from 0 to 5). X_i corresponds to the vectors of explanatory variables, *i.e.* the individual's personal characteristics (physical, socio-demographic, socio-economic, education and leisure). The higher the value of y_i^*, the more the individual is risk averse / prudent / temperate. To be more precise, as regards the degree of risk aversion, we have: $y_i = 0$ exhibits risk seeking, $y_i = 1$ exhibits risk neutrality, $y_i = 2, 3, 4, 5$ exhibit risk aversion (the degree of risk aversion increases with the value of y_i). For prudence and temperance, the higher the y_i, the more prudent / temperate the individual is. This classification follows those introduced by Noussair *et al.* [43]. These interpretations are valid for both the gain and loss domains.

5 Results

In this section, we first have a quick look at the subjects (Section 5.1). Then, we focus on the inter-domain correlations of features (Section 5.2), and intra-domain correlations between the different features of preferences (Section 5.3).

5.1 The subjects at a glance

The following set of tables (Table 2) provides the main information about the subjects. Exhaustive data are provided in Appendix B.

From this set of three tables, we can see that the subjects in our sample were on average 21.22 years old, 1.72 meters high and weighed 65 kg. 54% of them were women, and 80% of the sample was composed of French subjects. Moreover, the sample was mainly composed of subjects with a bachelor's degree, and a majority of our subjects were atheists. Concerning their parents' jobs, we used the French classification of jobs (PCS) introduced by the French Statistics Institute (INSEE).[5] Most of our subjects have parents whose jobs belong to the

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[5]See: https://www.insee.fr/fr/metadonnees/pcs2003/categorieSocioprofessionnelleAgregee/1 . We merged PCS 7 (retired) and 8 (jobless). For the father's job, we also created PCS Cat. 0 corresponding to fathers who were deceased.

category of higher intellectual professions (PCS Cat. 3).

Additional information (especially on leisure) are available in Appendix B.

Table 2: Main data about the subjects

Variable	Min	Max	Mean	Standard Dev.
Age	18	35	21.22	2.560
Height	153	200	172.32	9.004
Weight	43	100	65.04	11.686

Variable	Definition	Nb of subject	%
Gender	1 if the subject is a woman	133	54.1
French	1 if s/he is French	198	80.5

Variable	Definition	Nb of subjects	%
Study	Study level reached		
	Cat. 1: High school diploma +5	7	2.8
	Cat. 2: High school diploma +3	195	79.3
	Cat. 3: High school diploma	44	17.9
Religion	Subject's religion		
	Cat. 1: Catholic	50	20.3
	Cat. 2: Protestant	12	4.9
	Cat. 3: Orthodox	17	6.9
	Cat. 4: Muslim	24	9.8
	Cat. 5: Others	10	4.1
	Cat. 6: Atheist	133	54.1
Mother's PCS	Socio professional category of the subject's mother		
	Cat. 1: Farmer	1	0.4
	Cat. 2: Artisan, trader and entrepreneur	7	2.8
	Cat. 3: Executive and higher intellectual profession	69	28
	Cat. 4: Intermediate profession	59	24
	Cat. 5: Employee	62	25.2
	Cat. 6: Worker	8	3.3
	Cat. 7: Retired and other person without job	40	16.3
Father's PCS	Socio professional category of the subject's father		
	Cat. 0: Died	4	1.6
	Cat. 1: Farmer	3	1.2
	Cat. 2: Artisan, trader and entrepreneur	32	13
	Cat. 3: Executive and higher intellectual profession	75	30.5
	Cat. 4: Intermediate profession	22	8.9
	Cat. 5: Employee	28	11.4
	Cat. 6: Worker	51	20.7
	Cat. 7: Retired, person without job	31	12.6

5.2 Are we all schizophrenics? The correlation of preferences between gain and loss

In this subsection, we wonder whether individuals exhibit different kinds of preferences depending on whether they face gain or loss. Moreover, we aim to show which individual characteristics explain these preferences. For that purpose, for each feature of preferences, we begin by commenting on the descriptive statistics presented in Table 3 and Figure 2 below; second, we present the results of the correlation and third, the results of the regression analysis introduced in Section 4.

Table 3: Average number of safe, prudent and temperate choices: gain vs. loss domain

	Nb of A choices Gain domain	Nb of A choices Loss domain
Risk aversion	2.80 [1.517]	4.41 [0.930]
Prudence	2.63 [1.592]	1.29 [1.240]
Temperance	3.42 [1.598]	2.87 [1.580]

Standard deviation in [.]   .

Figure 2: Distributions of the number of safe, prudent and temperate choices, in the gain and loss domain respectively
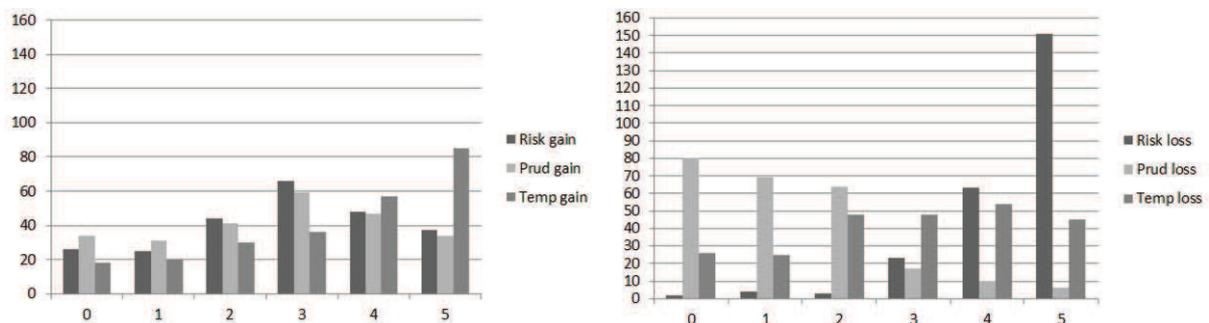
5.2.1 Risk aversion

Descriptive statistics. Our results indicated that the participants were risk averse on average in both the gain and the loss domains (see Table 3). The average numbers of safe choices (2.80 in the gain domain, 4.41 in the loss domain) were always significantly different from 2.50 at the 1% level, confirming the robustness of these preferences. We observed that individuals are somewhat more risk averse when facing loss than when facing gain.

This result is different from the traditional "reflection effect" indicating that individuals are risk averse over gains and risk seeking over losses. Such a result has been proved experimentally under different elicitation procedures, through auctions (Di Mauro and Maffioletti

[39]), Multiple Price List method of Holt and Laury [33] (Chakravarty and Roy [8], Gazda *et al.* [27]), Dospert scale (Gazda *et al.* [27]). Our result suggests that such a reflection effect does not appear with the model-free elicitation procedure proposed by Noussair *et al.* [43], and then that this reflection effect may be procedure-dependent or context-dependent (expected utility for the Holt and Laury task for example).

From Figure 2 above, we can remark that, in the gain domain, safe choices were roughly normally distributed around the value of 3, while in the loss domain the distribution was highly skewed on the right: 61% of subjects (151/246) made 5 safe choices in the loss domain (and 87% (214/246) made 4 or 5 safe choices). The degrees of risk aversion were thus relatively heterogeneous in gain, but quite homogeneous in loss: our subjects suffered from a "smooth schizophrenia" on that point. To complete the observation of the distributions, we can see that 24.54% (53/246) of the subjects made the same number of safe choices in the gain as in the loss domain, while 72.76% (179/246) of them made a higher number of safe choices in the loss than in the gain domain (only 5.7% (14/246) of the subjects did the opposite).

Correlation. We also investigated the correlation of behavior towards risk between gain and loss domains. For that purpose, we assessed the correlation of the number of safe choices between domains with the correlation coefficient of Pearson. The coefficient was positive and significant at the 10% level, but relatively low ($r = 0.112$, $p = 0.079$). This result is close to Schoemaker [48] who concluded that there was a weak correlation between risk attitude in the gain and loss domains.

Regression. Regarding the characteristics that explain individuals' preferences, Table 8 in Appendix C provides us with the results of the regressions introduced in the preceding section.

First, we observed that in the gain domain, the older the subject, the lower his degree of risk aversion. This result is consistent with the literature indicating that risk aversion decreases with age up to 65 years (Outreville [44]), and the oldest of our subjects was 35 years old.

Second, socio-economic and cultural variables have an impact on the subjects' degree of risk aversion. French subjects were significantly less risk averse than others in the gain domain. Still in the gain domain, it appeared that members of the Orthodox church (Religion 3) were more risk averse than Atheists. This result is in line with previous ones indicating that religion may be a determinant of an individual's risk aversion (Barsky *et al.* [5], Halek and Eisenhauer [29]).

Finally, in the gain domain, we observed that the parents' professions had an impact on risk aversion. Students with a mother in PCS 5 (Employee) or 6 (Worker) had a significantly higher risk aversion than students with a mother in PCS 7 (Retired or jobless). The father's job had a low impact since only the students with a father in PCS 2 had a lower risk aversion than students with a father in PCS 7. This result is different from those of De Paola [45] showing that only the father's job has an impact. Finally, loving art and computing seemed to increase risk aversion, while loving music decreased risk aversion.

Note that we created two new variables called Var_study and Var_curri. Var_study combines Cat 1. and Cat 2. of the variable Study, distinguishing subjects with a university

degree ($Var_{study} = 1$) from those with a high school degree $Var_{study} = 0$. Var_curri_1 combines Cat. 2 and 3 of Curriculum, Var_curri_2 combines Cat. 1, 4 and 5 of Curriculum and Var_curri_3 corresponds to hard sciences (Cat. 3 of Curriculum). However, none of these variables had a significant impact on individuals' behavior towards risk.

In the loss domain, very few variables impacted the students' risk aversion. Only having a father in PCS 1 and the Cooking variable had a significant and negative effect on risk aversion.

Note that Table 8 (Appendix C) indicates a negative effect of Gender on risk aversion but that this effect is not significant. This result is different from what is traditionally obtained in the literature, *i.e.*, significant and positive impact of being a woman (Jianakoplos and Bernasek [36], De Paola [45]). Interestingly, note that other studies also found no significant gender differences (Schubert et al. [49], Harrison et al.[30]), so no consensus seems to emerge.

Our main findings can be summarized as follows.

Result 1. *When considering the individuals' degree of risk aversion, on average individuals:*
(i) suffer from a smooth schizophrenia, since they are risk averse in gain and rather more risk averse in loss;
(ii) their attitudes towards risk are positively and significantly correlated between domains;
(iii) their degree of risk aversion in gain depends on physical characteristics (age) and socio-economic and cultural ones (nationality, religion, and mother's and father's job);
(iv) but their gender has no significant impact on their preferences.

5.2.2 Prudence

Descriptive statistics. Our results indicate that, on average, the individuals were prudent in the gain domain (2.63 significantly higher than 2.5 at the 1% level - see Table 3), but imprudent in the loss domain (1.29 significantly lower than 2.5 at the 1% level). Here, there was schizophrenia between the two domains.

Figure 2 shows that, as for risk aversion, in the gain domain, the number of prudent choices was roughly normally distributed around the value of 3. However, in the loss domain, they decreased from 0 to 5, with a high concentration on the left of the distribution: 86.5% of subjects (213/246) made 2 or fewer prudent choices in the loss domain. We also notice that 19.5% (48/246) of the subjects made the same number of prudent choices in the two domains, while 67.89% (167/246) of them made a higher number of prudent choices in the gain than in the loss domain.

Correlation. As regards the correlation of attitudes towards prudence between the two domains, a significant, positive and strong correlation was found at the 1% level ($r = 0.294$, $p = 0.000$): on average, for each individual, the higher the degree of prudence in one domain, the higher the degree of prudence in the other domain[6].

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[6]We also clearly observed this result through the calculation, for each given degree of prudence in one domain, of the average degree of prudence in the other domain: it clearly appeared that the higher the degree of prudence in one domain, the higher the average degree of prudence in the other domain.

Regression. Still looking at the results of the regressions (see Table 8 in Appendix C), we can see that, contrary to what prevails for risk aversion, gender had an impact on prudence, both in the gain and loss domains. However, the impact was different across the domains: in gain, women were significantly less prudent than men but when facing loss, women were significantly more prudent than men.

Note that the effect of the Age was similar for prudence and risk in the gain domain, *i.e.*, being both significant and negative.

Remark also that the Weight variable was significant and negative in the loss domain.

Another interesting finding was that, contrary to what prevails for risk aversion, the curriculum had a significant impact on the degree of prudence. An interesting result was that subjects with a background in "Economy, management" and "Sociology, psychology" were less prudent in gain than those with a background in "Hard sciences". In the loss domain, the curriculum also had an impact. The Var_curri_1 variable combining Cat. 2 and 3 of Curriculum was significant and negative, meaning that students with a background in Economics, management and law showed a lower degree of prudence than those in Hard sciences.

The parents' jobs also had an impact on the degree of prudence. However, the father's job had a different impact than the mother's one. Having a father in PCS 2 and 4 decreased the degree of prudence in gain (relatively to having a father in PCS 7), while having a father in PCS 1 increased it. Having a mother in PCS 2 and 6 in the gain domain and in PCS 3 in the loss domain increased the degree of prudence in relation to having a mother in PCS 7.

Finally, some variables related to leisure were significant: Art had a positive effect on the degree of prudence in the gain domain, while Music and Reading tended to decrease the degree of prudence in loss.

Our main findings can be summarized as follows.

Result 2. *When considering the individuals' degree of prudence, on average individuals:*

(i) suffer from schizophrenia, since they are prudent in gain but imprudent in loss;

(ii) their attitudes towards prudence are positively and significantly correlated between domains;

(iii) their gender has an impact on their degree of prudence, but this impact is different depending on the domain;

(iv) their curriculum has a significant impact in both domains.

5.2.3 Temperance

Descriptive statistics. Table 3 indicates that, on average, the individuals were temperate both in the gain (3.42) and loss (2.87) domains; these two values were different from 2.50 at the 1% level. So there was no schizophrenia when looking at temperance.

Looking at the distributions (Figure 2), it clearly appears that temperate choices in gain were right-skewed: 72% of the subjects (178/246) made 3 or more temperate choices in the gain domain. However, the distribution was more homogenous in the loss domain (only 60% of the subjects (147/246) made 3 or more temperate choices). Our results also indicate that 25.6% (63/246) of the subjects made exactly the same number of temperate choices in the gain and loss domains. 48.78% (120/246) of the sample made a higher number of temperate choices in the gain than in the loss domain.

Correlation. When looking at the correlation of temperate choices between the two domains we observe, as for risk aversion, a positive, significant (at the 10% level) but relatively low correlation ($r = 0.107$, $p = 0.093$).

Regression. As regards the individual characteristics which could explain temperance, few of the variables we collected had a significant impact on temperate choices.

In the gain domain, Religion 3 was significant and negative, meaning that members of the Orthodox church were less temperate than Atheists. In addition, having a father in PCS 0, 4 or 6 increased the degree of temperance as compared to having a father in PCS 7.

In the loss domain, it is interesting to note that Gender was significant and negative: women were less temperate than men in loss. Religion 5 was significant and positive. Having a mother in PCS 6 led to a higher degree of temperance than having a mother in PCS 7. Concerning leisure, loving cinema had a significant and positive effect on the degree of temperance.

Our main findings can be summarized as follows.

Result 3. *When considering the individuals' degree of temperance, on average individuals:*
(i) do not suffer from schizophrenia since they are temperate both in gain and loss domain;
(ii) their attitudes towards temperance are positively and significantly correlated between domains;
(iii) but their degree of temperance is hard to explain: only some religions and parents' jobs have an impact on temperate choices.

To conclude this Section 5.2 two remarks can be made.

First, note that our Pseudo R^2 of McFadden values presented in the last row of Table 8 are low, meaning that our variables poorly explain the individual's behavior towards risk, prudence and temperance in both domains. We can think about other variables than those considered here that may play a role in explaining individual preferences. Clearly, the income level should have a significant impact. However, we studied a sample composed of students, considered in experimental economics as a homogeneous population in terms of income. In addition, we also considered the mother's and father's PCS to try to apprehend such an effect, without any great success.

Second, note that when we compare our results with those of Noussair *et al.* [43], in the gain domain our results are close to theirs: Noussair *et al.* [43] found that, on average in their sample, the individuals made 3.38 non-risky choices, 3.45 prudent choices and 3.0 temperate choices. More generally, these trends are traditional in the literature (Tarazona-Gomez [51], Ebert and Wiesen [19], [20], Deck and Schlesinger [15]), but our study provided additional results in the loss domain.

5.3 Correlations between risk aversion, prudence and temperance in a given domain

As explained in Section 4, we tested for potential bilateral correlation between each feature of preferences for each domain. Table 4 presents the correlation coefficient of Pearson between risk, prudence and temperance in the gain and loss domains.

Table 4: Pearson coefficient in the gain and loss domain

	Gain domain			Loss domain		
	Risk	Prud.	Temp.	Risk	Prud.	Temp.
Risk	1	0.312***	0.037	1	0.216***	0.154**
Prudence		1	0.197***		1	0.215***
Temperance			1			1

Significance level: * 10%, ** 5%, *** 1% .

We can observe that all the bilateral correlations were positive and significant either at the 1 or 5% level, except concerning attitude towards risk and temperance in the gain domain, that are not significantly correlated. We thus obtained the following result:

Result 4. *All the bilateral correlations between attitudes towards risk, prudence and temperance were positive and significant, whatever the domain; with one exception, the correlation between risk and temperance in the gain domain.*

These results are different from those of Deck and Schlesinger [15] who found a positive correlation between risk aversion and temperance in the gain domain, which is the only correlation that is not significant in our case. These results are also different from those of Tarazona-Gomez [51] who found no correlation between risk aversion and prudence, while such a result was obtained in our experiment both in the loss and gain domains. Such differences in terms of results suggest that the correlation between risk aversion, prudence and temperance may be procedure-dependent.

6   Conclusion

This paper analyzes individuals' preferences towards risk, prudence and temperance, both in the gain and loss domains. More precisely, we analyzed the inter-domain correlations for each feature of preferences but also, for a given domain, the intra-domain correlations between features of preferences. In addition, we studied the determinants of each feature of preferences. Four main results appeared.

First, as an answer to the question asked in the title, we can say that schizophrenia is feature-dependent. We observe that individuals are smoothly schizophrenic as regards risk aversion because they are more risk averse in loss than in gain. Prudence is characterized by strong schizophrenia (*i.e.*, by prudence in the gain domain but imprudence in the loss domain) while for temperance, the behavior seems to be more consistent across domains.

Second, we highlight that, for each feature of preferences, there is a positive and significant correlation between the individual's attitude in the gain and in the loss domain.

Third, the individual characteristics which have an impact on decision-making are different among the features (risk aversion, prudence and temperance). Moreover, for a given feature, the explanatory variables are generally different between domains.

Finally, we show that all the bilateral correlations between attitudes towards risk, prudence and temperance in the gain and loss domains are positive and significant, except

concerning attitude towards risk and temperance in the gain domain, which are not significantly correlated.

These results may be of particular interest for several reasons.

First, our paper provides empirical evidence of the alternation in the signs of the derivatives of the utility function in the gain domain, but provides a counter-example in the loss domain. Such a result highlights the need to pay attention to the domain dimension in economic analysis of decision-making under risk.

Second, our results provide relevant information for the modeling of economic behaviors. The results suggest that we can assume that individuals are risk averse in the gain and loss domains, prudent in the gain domain and imprudent in the loss domain, and temperate in both domains. The difference in terms of the number of safe, prudent and temperate choices also provide information on the strength of these different attitudes.

Third, as regards future experiments, our results indicate that it seems relevant to elicit individuals' attitudes in both domains. While for risk aversion and temperance, the attitudes are similar in the gain and loss domains (*i.e.*, risk averse and temperate), the strength of the attitude is different: risk aversion is stronger in the loss than in the gain domain, while temperance is stronger in the gain than in the loss domain. In addition, attitude towards prudence differs between the domains, confirming the need to elicit preferences in both the gain and loss domains.

Finally, our results concerning the determinants of individuals' preferences towards risk, prudence and temperance may be helpful in different contexts. For example, our results indicate that, in the gain domain, younger people are more risk averse and more prudent on average than older people, suggesting that this segment of the population could be more prone to take safe decisions and accumulate wealth to face risk. It may then be relevant to offer them savings products with little or no risk. In the same vein, Courbage and Rey [10] underline that more prudent individuals realize less health prevention. In this context, it may be interesting to know the individual characteristics of prudent people in order to identify some potential levers to incite them to increase prevention. For instance, our results reveal that, in the loss domain (which seems more relevant than the gain domain when dealing with health prevention), men are less prudent than women and younger people are less prudent than older ones. Such a finding suggests that awareness-raising activities should be conducted mainly among young men.

An interesting extension of this paper would be to conduct a similar experiment but focusing on ambiguity aversion, ambiguity prudence and ambiguity temperance. Research in this direction has already been undertaken. Baillon *et al.* [4] have recently proved that decision-makers are significantly ambiguity averse, ambiguity prudent and ambiguity temperate.

Acknowledgments

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A   Example of a choice task in the loss domain

Figure 3: Examples of choice tasks in the loss domain
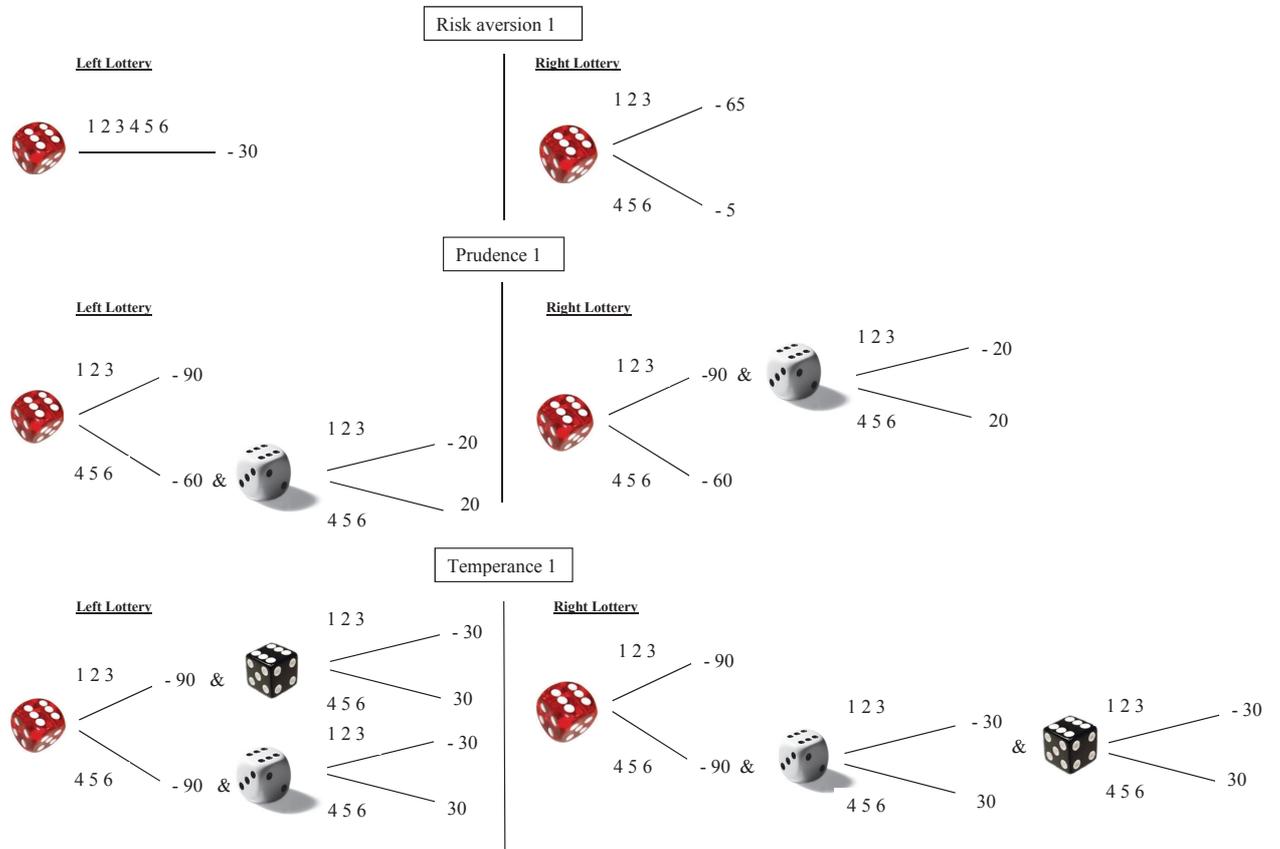
B Individual characteristics (exhaustive data)

Table 5: Continuous variables

Variable	Min	Max	Mean	Standard Dev.
Age	18	35	21.22	2.560
Height	153	200	172.32	9.004
Weight	43	100	65.04	11.686

Table 6 shows that 54% of our sample is composed of women and 80% of the sample is made up of French subjects. The leisure of our 246 subjects is broken down into 9 items: sport, music, reading, cinema, travel, computing, cooking, art and trips, and the most represented are sport and cinema.

Table 6: Dummy variables

Variable	Definition	Nb of subject	%
Gender	1 if the subject is a woman	133	54.1
French	1 if s/he is French	198	80.5
Sport	1 if s/he likes sport	158	64.2
Music	1 if s/he likes music	53	21.5
Reading	1 if s/he likes reading	54	22
Cinema	1 if s/he likes cinema, TV	75	30.5
Travel	1 if s/he likes traveling	32	13
Computing	1 if s/he likes computing, video games, internet	33	13.4
Cooking	1 if s/he like cooking	13	5.3
Art	1 if s/he likes photography, art, drawing	33	13.4
Trips	1 if s/he like tripping with friends, shopping, restaurant	37	15

In addition, Table 7 indicates that the sample is mainly made up of subjects having a high school diploma +3, in economy and management, that they are atheists, and their mother's and father's PCS is Cat. 3.

Table 7: Discrete variables

Variable	Definition	Nb of subjects	%
Study	Study level reached		
	Cat. 1: High school diploma +5	7	2.8
	Cat. 2: High school diploma +3	195	79.3
	Cat. 3: High school diploma	44	17.9
Curriculum	Curriculum followed by the subject		
	Cat. 1: Others	12	4.9
	Cat. 2: Law	30	12.2
	Cat. 3: Economy, management	124	50.4
	Cat. 4: Sociology, psychology	11	4.5
	Cat. 5: Language, literature	8	3.3
	Cat. 6: Hard sciences	61	24.8
Religion	Subject's religion		
	Cat. 1: Catholic	50	20.3
	Cat. 2: Protestant	12	4.9
	Cat. 3: Orthodox	17	6.9
	Cat. 4: Muslim	24	9.8
	Cat. 5: Others	10	4.1
	Cat. 6: Atheist	133	54.1
Mother's PCS	Socio professional category of the subject' mother		
	Cat. 1: Farmer	1	0.4
	Cat. 2: Artisan, trader and entrepreneur	7	2.8
	Cat. 3: Executive and higher intellectual profession	69	28
	Cat. 4: Intermediate profession	59	24
	Cat. 5: Employee	62	25.2
	Cat. 6: Worker	8	3.3
	Cat. 7: Retired and other person without job	40	16.3
Father's PCS	Socio professional category of the subject' father		
	Cat. 0: Died	4	1.6
	Cat. 1: Farmer	3	1.2
	Cat. 2: Artisan, trader and entrepreneur	32	13
	Cat. 3: Executive and higher intellectual profession	75	30.5
	Cat. 4: Intermediate profession	22	8.9
	Cat. 5: Employee	28	11.4
	Cat. 6: Worker	51	20.7
	Cat. 7: Retired, person without job	31	12.6

C   Regressions

Table 8 presents the estimation results for the six regressions.

Table 8: Estimation results

Variable	Risk gain	Risk loss	Prudence gain	Prudence loss	Temperance gain	Temperance loss
Age	-.112** [.054]	.065 [.070]	-.089* [.053]	.013 [.054]	.046 [.054]	.057 [.046]
Height	-.002 [.021]	.009 [.024]		-.023 [.021]		
Weight	-.014 [.014]	-.005 [.017]		-.031** [.015]		
Gender (0 = men)	-.631 [.396]	-.184 [.473]	-.752*** [.259]	.736* [.409]	-.266 [.278]	-.737*** [.269]
French (0 = not French)	-.917*** [.354]	.133 [.416]	.338 [.346]	-.202 [.355]	.479 [.354]	
Study 1		-.676 [1.052]				
Study 2		-.197 [.398]				
Study 3 (ref)						
Var_Study	-.318 [.346]		-.378 [.342]	-.509 [.346]	.003 [.341]	
(0 = high school)						
Curriculum 1		-.174 [.719]	-.242 [.591]			
Curriculum 2		-.365 [.506]	-.427 [.423]			
Curriculum 3		-.241 [.361]	-.659** [.297]			
Curriculum 4		-.761 [.754]	-1.534** [.631]			
Curriculum 5		-.111 [.901]	-.558 [.710]			
Curriculum 6 (ref)						
Var_curri_1	.172 [.298]			-.744*** [.299]	-.074 [.294]	
Var_curri_2	-.372 [.429]			-.456 [.426]	.461 [.435]	
Var_curri_3 (ref)						
Religion 1	.108 [.322]	.005 [.364]	-.178 [.314]	.447 [.324]	.163 [.319]	-.063 [.310]
Religion 2	-.411 [.565]	.381 [.711]	-.755 [.564]	.198 [.572]	.490 [.575]	-.201 [.545]
Religion 3	1.031* [0.567]	-.374 [.625]	.376 [.550]	.551 [.573]	-.965* [.558]	-.232 [.511]
Religion 4	-.336 [.450]	.540 [.593]	.017 [.440]	-.228 [.462]	-.346 [.457]	.084 [.428]
Religion 5	.791 [.620]	.073 [.713]	.783 [.606]	.141 [.628]	.112 [.610]	1.030* [.614]
Religion 6 (ref)						
Father's PCS 0	.431 [.983]	18.851 [7357.237]	-.001 [.972]	.072 [1.009]	2.423** [1.247]	-.425 [.964]
Father's PCS 1	1.025 [1.242]	-2.001* [1.243]	2.611* [1.406]	-1.145 [1.184]	1.869 [1.292]	1.351 [1.186]
Father's PCS 2	-.826* [.495]	.006 [.557]	-1.267*** [.498]	-.675 [.509]	.235 [.493]	-.634 [.483]
Father's PCS 3	-.525 [.426]	.224 [.491]	-.230 [.420]	-.542 [.438]	.540 [.429]	-.165 [.416]
Father's PCS 4	-.367 [.564]	.303 [.649]	-1.004* [.562]	.381 [.573]	.974* [.569]	-.093 [.557]
Father's PCS 5	-.145 [.518]	-.617 [.573]	.053 [.511]	-.123 [.526]	-.155 [.514]	.697 [.510]
Father's PCS 6	-.579 [.467]	.574 [.550]	-.034 [.453]	.332 [.471]	.826* [.469]	-.305 [.449]
Father's PCS 7 (ref)						
Mother's PCS 1	.335 [1.866]	18.606 [.000]	.468 [1.838]	-19.879 [.000]	-1.947 [1.905]	.091 [1.837]
Mother's PCS 2	-.035 [.795]	-.401 [.973]	2.285*** [.797]	.802 [.801]	.851 [.863]	-.017 [.763]
Mother's PCS 3	.154 [.404]	-.443 [.486]	.317 [.399]	.695* [.416]	-.187 [.408]	.261 [.392]
Mother's PCS 4	.276 [.415]	-.669 [.491]	.650 [.415]	.178 [.428]	-.703* [.419]	.137 [.407]
Mother's PCS 5	.821** [.398]	-.192 [.493]	.572 [.394]	.476 [.405]	-.628 [.400]	.033 [.384]
Mother's PCS 6	1.562** [.766]	.725 [.997]	2.530*** [.791]	.852 [.746]	.382 [.801]	1.436** [.749]
Mother's PCS 7 (ref)						
Sport (0 = no sport)	.132 [.274]	-.097 [.324]		-.119 [.274]	-.212 [.267]	
Music (0 = no music)	-.529* [.309]	-.469 [.366]	-.454 [.297]	-.639** [.307]		
Reading (0 = no reading)		-.220 [.364]		-.551* [.304]	-.247 [.309]	-.252 [.295]
Cinema (0 = no cinema)	.279 [.271]	.090 [.319]	.311 [.269]		-.275 [.276]	.651*** [.261]
Travel (0 = no travel)	.201 [.381]	-.269 [.450]				
Computing	.682* [.385]	-.410 [.455]		.388 [.394]	-.457 [.385]	-.573 [.366]
(0 = no computing)						
Cooking (0 = no cooking)	.050 [.583]	-1.262* [.787]			.480 [.582]	
Art (0 = no art)	.954*** [.374]	.297 [.424]	.698** [.364]			
Trips (0 = no trip)	.013 [.343]	.377 [.394]			.315 [.343]	.521 [.329]
Pseudo R^2 McFadden	.076	.087	.071	.063	.042	.044

Significance level: * 10%, ** 5%, *** 1%; in [] Standard Error.