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Personality and Risk Aversion

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A number of papers have recently explored the relation between personality measures and risk aversion. However, research on risk aversion using the Myers-Briggs Type Indicator (MBTI) personality measure is scarce. The relation of various dimensions of the MBTI with risk aversion is at the moment under-researched compared to its use in the business and counseling world. To explore this relation, we carried out an incentivized experiment using 333 business school students. We find that according to our theoretical hypotheses, respondents scoring higher on Introversion, Sensing, Feeling and Judging are more risk averse. We also find women, Master's students, respondents coming from a quantitative background and respondents that do not follow the stock markets to be more risk averse. The relations highlighted between the MBTI dimensions and risk aversion correspond broadly to the findings already evidenced using Big 5 type of measures in studies using questionnaires or lotteries. This emphasizes the significant overlap between the two personality evaluation methods in relation to risk aversion. Our findings also underscore that the MBTI might be a useful tool in studies on risk aversion using lotteries, given the significant link of its dimensions with the elicited risk aversion in our study.

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Introduction

Recently, a number of papers have explored the link between personality traits and risk aversion (see Becker et al. 2012, or Lönnqvist et al. 2015, amongst others). One of the ways to measure personality is through the Myers-Briggs Type Indicator (MBTI). The MBTI takes its modern intellectual roots from Jung (1921) theory of psychological types. Cloninger (1996) underlined that at a fundamental level, one can expect more from the MBTI than simple descriptive results, thanks to this strong theoretical backbone. It is widely used in the business world, with an estimated 2 million people taking the test every year. It is one of the most popular instruments to assess individual differences in fields including strategy (Hodgkinson and Clarke 2007) or management and organization studies (Gardner 1996).

With the exception of one paper by Filbeck et al. (2005), papers trying to link risk aversion and personality have used the Big 5. Given the importance of risk aversion and its implication in the business world in terms of portfolio choice, insurance behavior or agents' remuneration (such as CEOs or traders), it would seem essential to understand its links with the widely used MBTI[1].

The lack of research on risk aversion using the MBTI likely stems from two main factors. First, in counseling the dimensions of the MBTI are often used as dichotomous and are then analyzed in interaction to the others to give 16 potential "types". However, research has shown that personality dimensions are not dichotomous, and that such fourth-degree patterns of interaction might not be warranted (Furnham et al. 2003). Second, the official MBTI we used in this research is under copyright, and each questionnaire costs around 10€ to administer, which can be a serious financial impediment to research[2].

In Table I, we rapidly present the four dimensions of the MBTI: from Extraversion (E) to Introversion (I), from Sensing (S) to Intuition (N), from Thinking (T) to Feeling (F) and from Judging (J) to Perceiving (P). As Furnham et al. (2003) underlined that the MBTI and the Big 5 (NEO PI-R[3]) overlap significantly, we also display in this table the partial correlations found by these authors between the two personality measures. In the same paper, these authors put out a call for future research, focusing on "comparing and contrasting the findings of studies on either the NEO PI-R or the MBTI and some common factor". In this paper, we answer this call for research, for risk aversion. We measure personality through the four dimensions of the MBTI on continuous scales on a sample of 333 business school students and study their link with risk aversion as measured by a modified and incentivized version of the Eckel and Grossman (2002) task.

As hypothesized, we find that subjects scoring higher on Introversion, Sensing, Feeling and Judging are more risk averse, with the effect for Sensing and Feeling being non-linear. This is coherent with the hypotheses already formulated in Filbeck et al. (2005). In addition, based on the partial correlations displayed in Furnham et al. (2003), this also corresponds broadly to the findings of the literature using the Big 5.

[1] See for instance Markowitz (1952) or Jondeau and Rockinger (2006) for portfolio choice, Outreville (2014) for insurance and Laffont and Martimort (2009) for agent remuneration

[2] In addition to the reluctance some researchers might have to use a "commercial tool".

Table I: Presentation of the MBTI dimensions and their link with the Big 5

Preferences for focusing attention	**Extraversion (E)** – Individuals main interest is the outer world of people and things. They draw energy from actions and social interactions. They tend to act first, then reflect, then act further. Their attitude is relaxed and confident. This preference correlates negatively with Neuroticism (-0.30) and positively with Extraversion (0.71) of the Big 5.	**Introversion (I)** – Individuals main interest is the inner world of concepts and ideas. They draw energy from internal reflections. They tend to reflect before acting, then reflect further. Their attitude is reserved and questioning. This preference correlates positively with Neuroticism (0.31) and negatively with Extraversion (-0.72) of the Big 5.
Preferences for acquiring information	**Sensing (S)** – Individuals focus on the present. They value tangible and concrete information they can perceive through their five senses. They are fact and detail oriented. This preference correlates negatively with Openness (-0.66) of the Big 5.	**Intuition (N)** – Individuals focus on future possibilities. They value more theoretical and abstract information, that cannot be immediately acquired by means of the physical senses. They try to understand the "big picture". This preference correlates positively with Openness (0.64) of the Big 5.
Preferences for making decisions	**Thinking (T)** – Individuals value logic above sentiment in decision making. They strive to attain objectivity and logic in their analysis of situations. They tend to be somewhat impersonal, more interested in things than in human relationships. They are more likely to be truthful than tactful. This preference correlates negatively with Agreeableness (-0.41) of the Big 5.	**Feeling (F)** – Individuals value sentiment above logic in decision making, with the aim of achieving social harmony. They are more interested in human relationships than in things. They are more likely to be tactful than truthful. This preference correlates positively with Agreeableness (0.28) of the Big 5.
Preferences for orientation to the outer world	**Judging (J)** – Individuals value living an orderly and organized life. They prefer control over their lives and plan accordingly. They dislike unexpected events. They like to settle matters as soon as possible. This preference correlates positively with Conscientiousness (0.46) of the Big 5.	**Perceiving (P)** – Individuals value living a flexible and spontaneous life. They adjust easily to the unexpected or the incidental. They like to keep decisions open for as long as possible. This preference correlates negatively with Conscientiousness (-0.46) of the Big 5.

The presentation of the dimension of the MBTI is a necessarily short summary from different sources, including mainly Briggs Myers and Myers (1995), Briggs Myers (2000), the MBTI practitioner manual, as well as Filbeck et al. (2005). The correlation of the MBTI with the dimension of the Big 5 are partial correlations, taken from Furnham et al. (2003). We only display the main ones.

1 Literature Review

Only one study so far has tried to link financial risk preferences directly with the MBTI personality (Filbeck et al. 2005). The study hypothesizes that respondents displaying preferences for E, N, T and P should be more prone to risk seeking. Conversely, a preference for I, S, F and J would lead to more risk aversion. These authors specifically measured variance aversion and skewness seeking to assess risk preferences.

This hypothesis of increased risk taking for higher scores in E, N, T and P makes sense from a theoretical standpoint. Extraverted (E) people tend to be more sensation seeking and impulsive (see for instance Campbell and Heller 1987), which is strongly associated with risk taking[4]. Intuitive (N) people are interested in future possibilities, which should make them more prone to accept risks to get potentially higher returns. People with a preference for thinking (T) focus on objective and logic decision making. For these two preferences, (N) and (T) we would therefore expect respondents to be closer to risk neutrality. Finally, perceiving (P) people prefer to adapt to situations rather than control them: variability is therefore less of a problem for them.

Such a hypothesis is also grounded in the literature using questionnaire measures. A study on two samples (Hammer and Kummerow 1996) underlines that *risk-taking and adventure*, as measured by the Strong Interest Inventory, was positively and significantly linked to Intuition (N) and Perceiving (P) for both samples. It was also significantly related to Extraversion (E) and Thinking (T) in one of the samples. In contrast, Myers and McCaulley (1989) underline that preference for *economic security*, as measured by the Salience Inventory and the Value Scale, was related to preference Introversion (I), Sensing (S), Feeling (F), and Judging (J). This is the exact opposite of the E, N, T, P relation to risk and adventure found by Hammer and Kummerow (1996).

Despite the theoretical and empirical logic of their hypotheses, Filbeck et al. (2005) only found clear support for their hypotheses for the Thinking preference. This fact could possibly be due to low power because of the small size of their sample (68 respondents) or the fact that they did not provide incentives, which can prompt more erratic behavior (see for instance Holt and Laury 2002).

Despite the relative lack of evidence concerning personality as measured by the MBTI, we can turn to studies using the Big 5 for more empirical grounding. Both the Big 5 and the MBTI share rather strong partial correlations on their dimensions, as shown in Table I.

Using a form of lottery task Borghans et al. (2009) underlined that respondents scoring higher in neuroticism and agreeableness - which would mean a preference for Introversion and Feeling, based on the correlations of Furnham et al. (2003) - were more risk averse. Using a lottery task, Lönnqvist et al. (2015) found that people scoring lower in extraversion of the Big 5 take less risks. Using a questionnaire measure, they underlined

[3]NEO PI-R standing for Neuroticism, Extraversion, Openness Personality Inventory-Revised.

[4]As put by Briggs Myers and Myers (1995), extraverts tend to see the water as shallow, whereas introverts tend to see it as deep. Thus extraverts tend to "plunge more readily into new and untried experiences".

that respondents who were less extraverted, displayed less openness, more agreeableness, more neuroticism and more conscientiousness were more risk averse. Based on the correlations of Furnham et al. (2003), it would mean a relation between higher scores in I, S, F, J and higher risk aversion. Becker et al. (2012) also highlighted the same pattern as measured through a questionnaire, using a representative sample. Overall, the evidence points towards a link between preferences I, S, F, J of the MBTI and higher risk aversion, as hypothesized by Filbeck et al. (2005). In addition, it appears that the Big 5 is particularly well linked with risk aversion when measured through questionnaires.

Based on both these theoretical and empirical streams of evidence, we hypothesize like Filbeck et al. (2005) that respondents displaying preferences for Introversion, Sensing, Feeling and Judging should be more risk averse[5]. As Filbeck et al. (2005) point out, the relation between risk aversion and the dimensions of the MBTI might be non-linear. We therefore also test for some common significant forms (namely logarithm and quadratic form), like Filbeck et al. (2005). Based on the theoretical framework of the MBTI, we test for simple interactions between attitudes (Introversion and Judging) and functions (Sensing and Feeling). As the MBTI is often used to characterize "types" that are the conjunctions of its four dimensions, it would be interesting to test whether there indeed interactions exist.

2 Methodology

Our final sample is composed of 333 students from a leading French Business school. After taking the 88 questions of the MBTI as part of a course, they were given our pen and paper questionnaire. We used a lottery task inspired from Eckel and Grossman (2002), shown in Table II, where lotteries are presented in order of increasing risk. We hypothesized a power utility function $u(x) = x^{\alpha}$ and elicited the associated coefficient of risk aversion out of this lottery task. It can be noted that since we use symmetric binary risks, our lotteries only differ in their variance (Ebert 2015). Our results can therefore be interpreted as both risk aversion or aversion to variance[6].

We incentivized the task by randomly selecting 10 participants whose chosen lottery would be played out. For these ten participants, the lotteries were played for the corresponding amounts and their gains were paid in cash. In absolute expected value, the monetary incentivization was therefore small. However, the 15-question experience took between 5 to 10 minutes to complete, which yielded an expected remuneration for the students of 6 to 12€ per hour (roughly 7 to 14$). As underlined by Drehmann et al. (2005), who used comparable amounts in a large scale experiment, a 12€ (14$) per hour remuneration corresponds to a well paid student job. Since the experiment was part of a graded course[7], and was one of the first modules students took after entering the school,

[5]Conversely, respondents displaying preferences for E, N, T, P should be more risk seeking.

[6]This is what leads us to prefer a method derived from Eckel and Grossman (2002) with symmetric risks rather than the classic Holt and Laury (2002) method, such as used in Wakolbinger et al. (2009) or Yang and Tackie (2016) or its modified version for field experiments presented in Teubner et al. (2015).

[7]The grade in the module did not depend on their answers to the MBTI or to our questionnaire,

Table II: Characteristics of the lotteries used in the experiment

	Probabilities		Alpha range	Characterization	Mean	StD	% of respondents
	50%	50%					
Lottery 1	30.00 €	30.00 €	$0.00 \leq \alpha \leq 0.57$	Strong risk av.	30.00	0.00	31.14 %
Lottery 2	21.25 €	40.00 €	$0.57 \leq \alpha \leq 0.63$	Mild risk av.	30.63	9.38	17.07 %
Lottery 3	17.50 €	45.00 €	$0.63 \leq \alpha \leq 0.81$	Weak risk av.	31.25	13.38	20.66 %
Lottery 4	12.50 €	51.25 €	$0.81 \leq \alpha \leq 1.15$	Risk Neutrality	31.88	19.38	17.37 %
Lottery 5	00.00 €	60.00 €	$1.15 \leq \alpha$	Risk Loving	30.00	30.00	13.77 %

This table presents the characteristics of the lotteries used in the experiment. The question asked was "Which lottery would you prefer to play?". From the response, we infer a range for a parameter alpha for a power utility function $u(x) = x^{\alpha}$. We also give the moments of the lotteries under consideration, where StD stands for Standard Deviation. Skewness is 0 for these lotteries. Moments of orders 4 and higher are determined by the first three moments in the case of binary lotteries (Ebert 2015). In the specific case of symmetric binary risk that we use, all odd order moments will be equal to 0, while centralized standardized even moments will all be equal to 1. This is why our results can safely be interpreted as both risk aversion or variance aversion, since there is no difference in higher order moments for these lotteries. The final column displays the percentage of respondents choosing a specific lottery. As can be seen, only 13.77% of our respondents are clearly risk lovers, 68.86% are clearly risk averse and 17.37% are risk neutral.

it is likely they took the experiment seriously. In this context there was also no psychological or financial cost to physically going into an experiment room: the incentivization was a bonus for the students who did not expect a remuneration for attending the class. Charness et al. (2016) further underline in a literature review concerning incentives in the lab that paying only a subset of participants as we did, might be a more cost-efficient way of collecting data: *"Overall, the majority of comparisons of paying all the participants versus only a subset of them indicate that the loss of motivation is small — much smaller than the implied reduction in actual payment."*. A particular point of concern regarding remuneration could be the proportion of risk neutral and risk lover respondents (see Holt and Laury 2002 for instance). As a means of comparison, the original article of Eckel and Grossman 2008 found 30% of individuals displaying risk neutrality or risk loving[8]. Using a similar methodology allowing for differentiation between risk neutrality and risk loving, Dave et al. (2010) found 10.7% of risk lovers. More recently Ebert and Wiesen (2014) found 11% of individuals to be risk lovers and 24% to be risk neutral over symmetric binary lotteries such as the one in the Eckel and Grossman (2008) task. Overall, it therefore seems that these two categories are not over-represented in our sample.

After computing some descriptive statistics, we ran an OLS regression and an ordered probit regression using the number of the lottery (from 1 to 5) as a dependent variable as well as an interval regression on the elicited coefficients of risk aversion. The OLS regression is a first approximation, confirmed by the ordered probit. Their advantage is that they do not assume a specific form of utility. They simply consider that the higher the number of the lottery the riskier it is. On the other hand, the interval regression can be directly interpreted in terms of coefficient alpha. Similar results across the three types of regression would point toward statistical robustness across different methodologies.

The main variable in our regressions are normalized scores on the MBTI dimensions

which was optional.

[8]The task used in their paper could not distinguish between the two.

(so that they range between 1 and 100[9]). The MBTI dimensions are often used as dichotomous within counseling, to provide a simpler and clearer determination of preferences for one of the poles of these dimensions. However, as underlined in a number of papers, in reality personality traits are a continuum (see amongst many others Furnham 1996, Furnham et al. 2003), and research generally uses continuous scores on these dimensions, as we do. We coded the scores in each dimension so that they rose up to 100, the more Introverted (I), Sensing (S), Feeling (F) and Judging (J) a respondent was, with a minimum of 1. If our hypotheses are true - namely that respondents being more I, S, F, J are more risk averse and choose lotteries associated with a lower coefficient α - we should consequently see significant *negative* coefficients in our regressions. We ran two specifications for each type of regression (OLS, ordered probit and interval). In the first one, we simply included the normalized scores on the MBTI dimensions, testing for simple linear relations. Following Filbeck et al. (2005) who found evidence of non-linearity in the relation between risk aversion and MBTI personality, we then tested for some common significant forms (namely logarithm and quadratic form). Based on the theoretical framework of the MBTI, we tested for simple interactions between attitudes (Introversion and Judging) and functions (Sensing and Feeling). We then included in this second specification the significant non-linear terms (namely, the logarithm of Sensing and the interaction between Introversion and Feeling). To test if our findings are not driven by over-fitting, we performed the most common form of cross-validation (Arlot et al. 2010), leave-one-out cross validation (Stone 1974).

We controlled for multiple covariates in these regressions. Experimental literature has underlined many times that women are more risk averse than men (see for instance Eckel and Grossman 2008), which sparks the need to control for gender in our regressions. Our sample is composed of 56.6% of women and 43.4% of men.

Recent evidence also suggests that respondents who are more comfortable in manipulating numbers make fewer mistakes in choosing between different lotteries. Depending on the task at hand, risk aversion elicitation might be biased either upward or downward (Andersson et al. 2016, Taylor 2016). We therefore controlled for quantitative abilities, by asking students about their major. Roughly two-thirds of our sample came from mathematic, engineering, economics, management, finance and accounting and were considered to have a quantitative background as opposed to those coming from more literary majors. We also included students' level of study. Our sample was composed of 59% of students in their last undergraduate year and 41% of students in their first year of a Master's degree.

Up to one-third of the students in our school are from abroad so their mother tongue was likely to be different from the language of the questionnaire. Recent studies have pointed toward a decrease in risk aversion when using a foreign language (see Hayakawa et al. 2016 for a review and the study 3.a in Costa et al. 2014 for an experiment using Holt and Laury 2002 type of lotteries). We therefore added a variable controlling for whether the questionnaire was taken in the respondent's native language or not.

[9]To avoid any confusion, we mean by normalized score : $\text{normalized score} = 100 \cdot \frac{x-(min(x)}{max(x)-min(x)}$

As it pointed out earlier by Shefrin (2000), and proven with success in multiple studies (see for instance Grable et al. 2004, 2006), market highs and market recent trends can change the risk tolerance of market actors and individual investors. These groups of people are hypothesized to be more risk tolerant following a rise in stock price and during a market high[10]. Some of our students actively follow the stock market, and might have been affected by the high level of equity index as well as the rise in these indices during the period of our study. Our study took place in February 2017, a period when the national equity index gained 5% and reached a 2-year high. We control for this potential bias by including two dummy variables to control for those students that are actively following the stock markets (11% in our sample) and regularly reading the financial press (42% in our sample). We also added a dummy variable to control for the fact that some of our respondents (21%) had already participated in other experiments during the year, which might have an effect on their responses to our own set of questions.

3 Results

As can be seen in Table III, splitting the sample into low scorers (below 50) and high scorers (equal or above 50) for each dimension already provides some support toward our hypotheses. We can see significant differences in the proportions of respondents choosing the safest lottery (the sure amount) between low and high scores for Introversion, Sensing and Judging. We can also see a significant difference for the Judging dimension for Lottery 2 (the second in order of maximum safety). These differences are totally coherent with our hypotheses. It is also interesting to notice the economic significance of these effects. We can see a mean difference of 15% in the proportion of people choosing the sure amount, between the low scorers and the high scorers for Introversion and Judging. The difference is only of 10% for Sensing, and marginally significant. For Judging, an additional 8% of the higher scorers choose Lottery 2, which is also relatively safe. Congruent with the fact that extraverts tend to be sensation seeking, we also see that people scoring lower in Introversion tend more often to choose the lottery corresponding to risk loving (difference of 10%, $p<0.01$). For Sensing, we can see that people scoring lower (who are therefore intuitive) move toward the lottery corresponding to risk neutrality. Hence, they maximize their expected returns, which conforms to our expectations. For Judging, the lower scorers tend to go for Lottery 3, 4 and 5. The difference is only significant for Lottery 4, even though the others are close to marginal significance. It is a bit disappointing to see no significant difference in this first analysis for the Feeling dimension, even though the effect is in the expected direction and very close to marginal significance for Lottery 2.

[10]Risk tolerance and risk aversion, if conceptually slightly different, are strongly related in practice as evidenced by Faff et al. (2008).

Table III: Percentage of respondents choosing a given lottery depending on their score on each dimension

Lottery	Introv.<50 Percent	Introv.≥50 Percent	Difference Proport.	*Proport. test P-Value*
1	24.60%	39.04%	14.44%***	*0.0047*
2	14.97%	19.86%	4.89%	*0.2398*
3	23.53%	17.12%	-6.41%	*0.1524*
4	18.72%	15.75%	-2.97%	*0.4793*
5	18.18%	8.22%	-9.96%***	*0.0089*
N	187	146		

Lottery	Sens.<50 Percent	Sens.≥50 Percent	Difference Proport.	*Proport. test P-Value*
1	25.37%	34.67%	9.30%*	*0.0718*
2	14.93%	18.59%	3.66%	*0.3836*
3	22.39%	19.60%	-2.79%	*0.5379*
4	25.37%	12.06%	-13.31%***	*0.0017*
5	11.94%	15.08%	3.14%	*0.4162*
N	134	199		

Lottery	Feel.<50 Percent	Feel.≥50 Percent	Difference Proport.	*Proport. test P-Value*
1	32.08%	30.40%	-1.68%	*0.7575*
2	12.26%	19.38%	7.12%	*0.1081*
3	21.70%	20.26%	-1.44%	*0.7636*
4	20.75%	15.86%	-4.89%	*0.2725*
5	13.21%	14.10%	0.89%	*0.8266*
N	106	227		

Lottery	Judg.<50 Percent	Judg.≥50 Percent	Difference Proport.	*Proport. test P-Value*
1	22.52%	37.91%	15.39%***	*0.0025*
2	12.58%	20.88%	8.3%**	*0.0454*
3	24.50%	17.58%	-6.92%	*0.1208*
4	23.18%	12.64%	-10.54%**	*0.0116*
5	17.22%	10.99%	-6.23%	*0.101*
N	151	182		

In this table, we present the percentage of respondents choosing each lottery. We split the respondents between those scoring higher than 50 and those scoring lower than 50 in each of the dimensions. We chose fifty as it is the middle of our scale that ranges from 0-100, but choosing the median would not significantly change the numbers. We carried out classical proportion tests between the proportion for each dimension and for each lottery.

In a first regression, we did not carry out any transformation on the data. We find that subjects scoring higher in Introversion and Judging are more risk averse ($p < 0.01$ in both cases), which is congruent with our hypotheses. Concerning covariates, we also find that women are more risk averse than men ($p < 0.01$), a finding already evidenced in a number of studies. This regression further highlights that subjects coming from a more quantitative background and subjects in their first year of a Master's degree as opposed to their final year of a Bachelor's degree are more risk averse ($p < 0.01$ in both cases). This relates to Andersson et al. (2016) as well as Taylor (2016) who underline that greater ability in manipulating numbers leads to fewer errors in lottery tasks. In contrast, subjects following the financial markets regularly are less risk averse ($p < 0.05$), which is coherent with the thesis of Shefrin (2000), given that the market was rising to a high during the period of our study.

As underlined by (Filbeck et al. 2005), the relation between risk preferences and personality dimensions might be non-linear. In a second regression, we therefore transformed data by including the natural logarithm of Sensing and adding an interaction between Introversion and Feeling. We find both these terms as well as the untransformed Sensing and Feeling preferences to be significant ($p < 0.05$) and marginally significant for the untransformed Sensing preference ($p < 0.1$) in the classic OLS regression. In the case of the ordered probit and interval regressions, we find these variables to be all marginally significant ($p < 0.1$) apart from the Feeling preference which reaches significance in the ordered probit ($p < 0.05$).

The interaction between Introversion and Feeling prevents the two linear effects from adding up, as can be seen in Figure 1(a), which depicts the effect of the interaction between Introversion and Feeling. Therefore, extraverts scoring higher on the Feeling preference are more risk averse, but the converse does not hold true for Introverts. Figure 1(a) shows that the impact of moving from scoring 0 in Feeling and 0 in Introversion to scoring 100 in Feeling and 0 in Introversion is a decrease of 0.4297 in the coefficient of risk aversion. Moving from 0 in Feeling and Introversion to a 100 in both these dimensions also leads to a decrease of 0.405 in the coefficient of risk aversion. It seems that the Feeling dimension acts as a form of boundary on risk aversion. This could be connected to the risk as feelings hypothesis, stating that affect has an important role in decisions under risk (Loewenstein et al. 2001). Respondents scoring higher on the Feeling dimension would then be particularly prone to letting affect drive their decisions. Other points of interest for this interaction with their exact values are highlighted in Figure 1(a) for the reader.

The addition of Sensing natural logarithm made the relation with risk aversion convex and L-shaped, with a rapid decrease as subjects move from being fully Intuitive (N) to scoring higher on Sensing (S), and a stabilization afterward, as seen in Figure 1(b). Moving from 1 (that is fully Thinking) to 46.3 on our Sensing scale would, according to our model, lead to a drop of 0.7 in the risk aversion coefficient. Becoming more Sensing than 46.3 then has no significant[11] further effect on the risk aversion coefficient.

[11] Using the Delta method, we find no significant impact on risk aversion of rising from 46.3 to 100 on

Table IV: Determinants of risk aversion

	OLS - Robust		Ordinal Probit		Interval regression	
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
	(p-value)	*(p-value)*	*(p-value)*	*(p-value)*	*(p-value)*	*(p-value)*
Introversion (I)	-0.0126***	-0.0305***	-0.0102***	-0.0261***	-0.0029***	-0.0073***
	(0.001)	*(0.002)*	*(0.001)*	*(0.003)*	*(0.001)*	*(0.004)*
Sensing (S)	-0.0013	0.0202*	-0.0001	0.0178*	0.0002	0.0053*
	(0.737)	*(0.065)*	*(0.987)*	*(0.079)*	*(0.817)*	*(0.071)*
ln(Sensing)		-1.0065**		-0.8294*		-0.2464*
		(0.026)		*(0.068)*		*(0.063)*
Feeling (F)	-0.00351	-0.0186**	-0.0026	-0.0156**	-0.0006	-0.0043*
	(0.380)	*(0.035)*	*(0.452)*	*(0.045)*	*(0.568)*	*(0.056)*
Interaction I*F		3.11E-04**		2.74E-04*		7.55E-05*
		(0.049)		*(0.058)*		*(0.066)*
Judging (J)	-0.0107***	-0.0096***	-0.0087***	-0.0078***	-0.0024***	-0.0021***
	(0.002)	*(0.005)*	*(0.001)*	*(0.004)*	*(0.003)*	*(0.009)*
Quant. Background	-0.47339***	-0.4970***	-0.4024***	-0.4263***	-0.1106***	-0.1179***
	(0.008)	*(0.006)*	*(0.005)*	*(0.003)*	*(0.009)*	*(0.005)*
Master	-0.4644***	-0.4426***	-0.4084***	-0.3970***	-0.1138***	-0.1069**
	(0.006)	*(0.009)*	*(0.005)*	*(0.007)*	*(0.007)*	*(0.011)*
Men	0.4483***	0.5092***	0.3918***	0.4506***	0.1230***	0.1346***
	(0.006)	*(0.002)*	*(0.003)*	*(0.001)*	*(0.001)*	*(0.001)*
Following markets	0.5850**	0.5931**	0.4731**	0.4895**	0.1365**	0.1394**
	(0.027)	*(0.024)*	*(0.019)*	*(0.016)*	*(0.021)*	*(0.018)*
Non-Native	0.2347	0.2618	0.2241	0.2531	0.0582	0.0611
	(0.378)	*(0.342)*	*(0.308)*	*(0.251)*	*(0.369)*	*(0.342)*
XP	-0.1207	-0.1544	-0.1126	-0.1439	-0.0329	-0.0414
	(0.488)	*(0.373)*	*(0.441)*	*(0.328)*	*(0.440)*	*(0.328)*
Reading fin. press	-0.0927	-0.0843	-0.1004	-0.0963	-0.0267	-0.0267
	(0.556)	*(0.592)*	*(0.445)*	*(0.465)*	*(0.486)*	*(0.483)*
Constant	4.3690***	7.9699***			1.0568***	1.9526***
	(0.001)	*(0.001)*			*(0.001)*	*(0.001)*
cut1			-1.8812***	-4.8915***		
cut2			-1.3879***	-4.3926***		
cut3			-0.7942***	-3.7932***		
cut4			-0.1426***	-3.1343***		
ln(sigma)					-1.2170	-1.2287
sigma					0.2961	0.2927
(Pseudo) R^2	0.145	0.161	0.144	0.161	0.137	0.154
N° of observations	333	333	333	333	333	333
AIC	1150.94	1148.70	1023.17	1020.69	1094.49	1089.65

In this table, we present the results of our regressions, with and without non-linear effects. Even though the classic OLS model is inherently wrong in the case of an ordered dependent variable, it is used as a first approximation. We used White (1980) sandwich estimate of variance to take into account departures from normality of residuals in the case of the classic OLS regressions. No other issue appeared concerning the assumptions supporting these 6 regressions. Mean VIF was 4.66 in the regressions including non-linear effects, which is still acceptable and is entirely due to said effects. As a robustness check, we centered the variables Introversion and Feeling before creating the interaction and regressed Sensing on ln(sensing) and included the error term in the regression instead of ln(sensing). This reduced the VIF below 2. There was no difference in the significance of the non-linear effects, and the pattern displayed in Figure 1(a) and 1(b) were identical. As these transformations made the intuitive interpretation harder, we decided to display the regressions with non-linear effects in the above Table without these transformations. In the case of the ordinal regression, using a logistic instead of a probit model did not change the pattern of results. The cut-offs indicated are significantly different from one another. Pseudo R^2 are calculated using the formula of Cox and Snell (1989). AIC stands for Akaike Information Criterion (Akaike 1973).

So people scoring higher on our Sensing scale are significantly more risk averse, but the change in risk aversion happens when one moves from being fully Intuitive to becoming more Sensing (from 0 to 46.3 on our Sensing scale), before stabilizing afterward (from 46.3 to 100)[12].

The other variables remain significant at the same level even with the addition of these new terms[13].

Overall, we therefore find evidence of increased risk aversion for subjects scoring higher in Introversion, Sensing, Feeling and Judging, as hypothesized.

A potential concern for our regressions might be that we over-fitted our data in the regressions where we use non-linear effects. To our knowledge, this problem was not treated in (Filbeck et al. 2005). To control for this in our paper, we performed cross-validation of our models. We used the most common form of cross-validation (Arlot et al. 2010) on our robust OLS and ordinal regression, leave-one-out cross validation (Stone 1974). The idea is basically to estimate the model on a sub-sample of n-1 observations (332 in our case) and see how well the model predicts the left out observation. Each data point is successively left out and used for validation. Average model statistics for the cross validation (RMSE and AME) show an improvement in favor of the model with non-linear effects (namely an interaction between Introversion and Feeling and the natural logarithm of Sensing). In addition, the Akaike information criterion (AIC) is minimized for the full model for the three types of regressions we performed, as seen in Table IV. This evidence, in addition to the fact that our findings are congruent with what is theoretically expected, would point to the fact that we did not over-fit. Nonetheless, the findings concerning Sensing and Feeling appear less robust than the ones concerning the Introversion and the Judging preferences and would definitely deserve replication, possibly on a larger sample.

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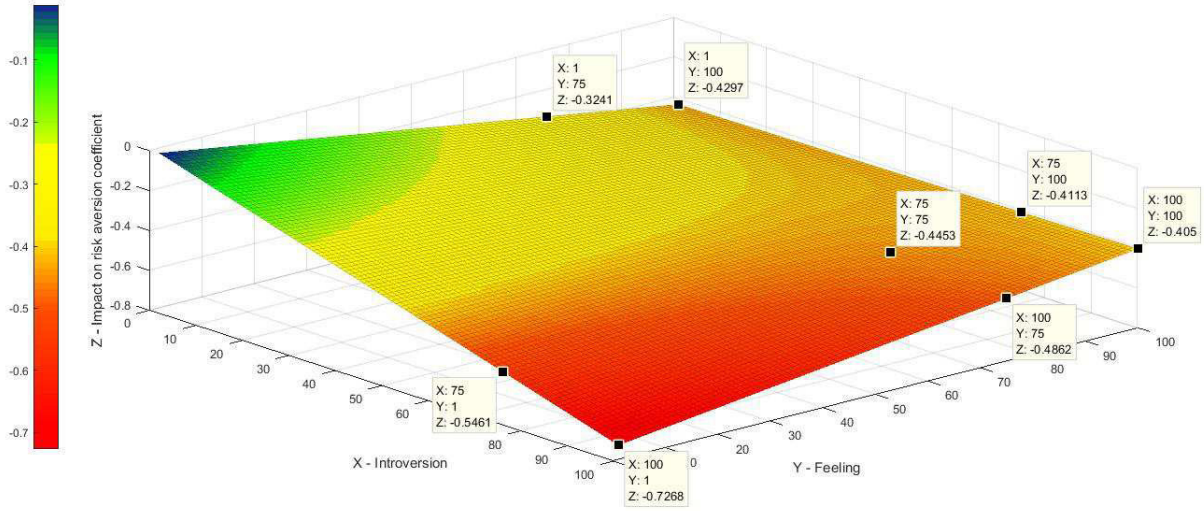
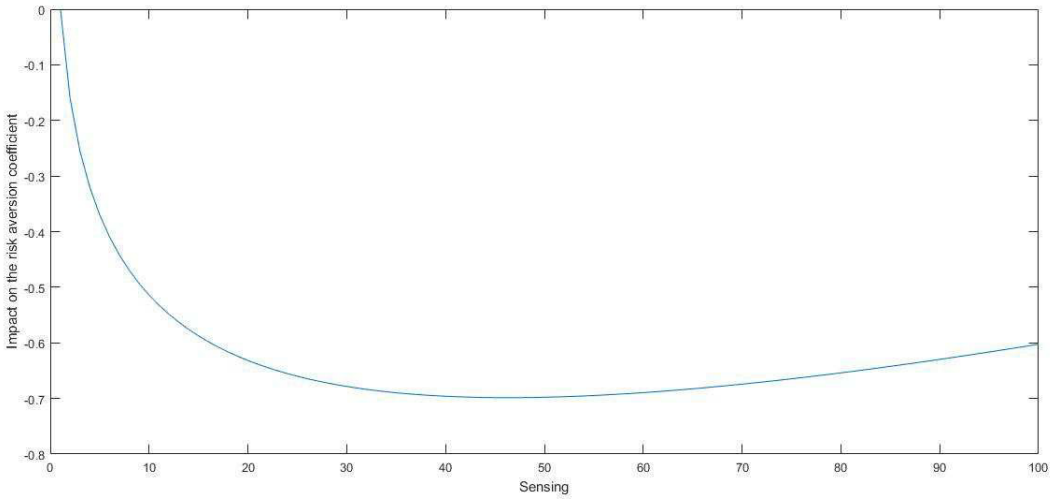
the Sensing scale, $X^2(1) = 1.86$, $p = 0.172$.

[12] As already underlined in our analysis of Table III, this does not make individuals scoring lower in Sensing risk loving but rather risk neutral. Individual scoring lower on our Sensing scale are indeed Intuitive. They are at ease with numbers and are interested in future possibilities Briggs Myers and Myers (1995). They are therefore not sensation seekers like extroverts, but simply value maximizers.

[13] Apart from being a Master's student rather than an undergraduate student, which goes from $p < 0.01$ to $p = 0.011$ in the case of the interval regression.



(A) Joint effect of Introversion and Feeling on α in the interval regression



(B) Effect of Sensing on α in the interval regression

Figure 1: Non-linear effects in the interval regression

These figures show the total effect of Introversion, Feeling and their interaction (Graph 1(a)) and the total effect of Sensing (Graph 1(b)) on the risk aversion coefficient alpha. Numbers are based on simulations run from the estimates of Table IV.

4 Conclusion

In this paper, we have explored the relation between MBTI personality measures and risk aversion. We measured risk aversion through an incentivized lottery task, derived from Eckel and Grossman (2002).

As we controlled for multiple covariates in our regressions, we were able to evidence in our data some relations previously found in other experimental studies. Namely, we find a gender effect, with women being more risk averse than men (see Eckel and Grossman 2008 for a review of this effect). We find that respondents with higher number skills (Master's students and students coming from a quantitative background) are more risk averse. This is congruent with Andersson et al. (2016), Taylor (2016) who assert that such skills are related to fewer errors in decision making in lottery tasks. We also find that respondents following the stock markets are less risk averse. This is coherent with the thesis of Shefrin (2000), stating that market actors are less risk averse during periods of boom or market highs. Our study was conducted during such a period, with the market rising to a 2-year high.

In keeping with our main hypotheses, we find evidence that people scoring higher on Introversion, Sensing, Feeling and Judging are more risk averse. For Sensing, the effect is non-linear, with a sharp increase in risk aversion up to a normalized score of 46.3 out of 100, and a stabilization afterwards. Similarly, an interaction appears between Feeling and Introversion, preventing the linear effect to add up.

Thanks to a larger sample, we are therefore able to prove the hypotheses formulated in Filbeck et al. (2005). In particular, the effects concerning the Introversion and the Judging preferences seem particularly strong and robust. It therefore appears that MBTI dimensions are significantly related to risk aversion, in a pattern resembling the one already observed for the Big 5 using questionnaires. It emphasizes again the significant overlap between these two major personality evaluation models. It also underlines that the MBTI might be an insightful tool to use in research on risk aversion using lotteries, as its dimensions appear well correlated to the elicited risk aversion obtained. Future avenues of research could consist in exploring the link between higher order preferences such as Prudence and Temperance and their link to the MBTI.

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