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The salience of informed risk: an experimental analysis

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Abstract

Purpose – Expanding on the real-world financial market framework and considering the current market turmoil, with cryptocurrencies (where contracts for difference (CFDs) are extremely common) (Hasso *et al.*, 2019) displaying unprecedented volatility, the authors aim to test in an online laboratory setting whether displaying a risk warning message is truly effective in reducing the level of risk taken and whether the placement of this method makes a difference.

Design/methodology/approach – To explore the impact of risk disclosure framing on risk-taking behavior, the authors conducted an online pair-wise lottery choice experiment. In addition to manipulating risk awareness through the presence or absence of risk warning messages of varying intensity, the authors also considered dynamic inconsistency, cognitive ability and questionnaire-based financial risk tolerance (FRT) scores. The authors aimed to identify potential relationships between these variables and experimentally elicited risk aversion. The authors' study offers valuable insights into the complex nature of risky decision-making and sheds light on the importance of considering dynamic inconsistency in addition to risk awareness and aversion.

Findings – The authors' results provide statistical evidence for the efficacy of informative and very salient messages in mitigating risky decision, hinting at several policy implications. The authors also provide some statistical evidence in support of the relationship between cognitive abilities and risk preferences. The authors detect that individual with low cognitive abilities scores display great risk aversion.

Originality/value – This study investigates the impact of risk warning messages on investment decisions in an online laboratory setting – a unique approach. However, the authors go beyond this and also examine the potential influence of dynamic inconsistency on decision-making, adding further value to the literature on this topic. To ensure a comprehensive understanding of the participants, the authors collect data on cognitive ability and FRT using questionnaires. This study provides a simple and cost-effective framework that can be easily replicated in future research – a valuable contribution to the field.

Keywords Individual decision-making, Risk, Dynamic inconsistency, Experimental economics, Information effect, Finance

Paper type Research paper

1. Introduction

In recent years, there has been a growing interest among policy makers and researchers in understanding the factors that influence individuals' risk perception and aversion in financial

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decision-making, particularly in the context of financial markets. Economic theories of choice have long recognized the crucial role of risk aversion and dynamic consistency in understanding the workings of financial markets and investment decisions. Risk aversion is the tendency of individuals to prefer a certain outcome over an uncertain one, even if the uncertain outcome has a higher expected value. This principle helps explain why investors often demand a premium for taking on additional risk.

Dynamic consistency, on the other hand, refers to the notion that an individual's preferences and behavior should be consistent over time. This is particularly important in financial markets, where decisions made today can have a significant impact on future outcomes. For instance, investors who take on excessive risk in a bull market may find themselves in a much worse position when the market turns bearish. However, the assumption of rational behavior has been increasingly challenged in recent years, with some economists arguing that investors are subject to cognitive biases and emotional responses that can lead to irrational decision-making. This has led to the development of behavioral finance, which seeks to incorporate psychological factors into economic models of decision-making. Consequently, researchers argued that market efficiency should be viewed only as a theoretical concept (Barberis and Thaler, 2003).

Considering this, policy makers and regulators have focused on addressing the issue of excessive risk taking by retail investors, particularly in markets where information is asymmetric and financial literacy is limited [1]. One example of this is the recent regulatory changes introduced by the European Union, which aim to create a framework that allows retail investors to make more informed decisions and take on more sustainable levels of risk (Decisions (EU) 2018/795 and 2018/796). One financial instrument that has been a particular focus of regulatory intervention is the contract for difference (CFD), a type of investment derivative known for its use of high leverage and easy access via online trading brokers.

In 2018, the European Securities Market Authority (ESMA) introduced a product intervention on CFDs and binary options for the retail investor market, which included measures such as limiting the level of leverage allowed and requiring the use of standardized risk warning messages [2]. The risk warning messages must disclose the risks involved in trading CFDs and state the percentage of retail investors who lose money when trading on the platform. An example of such a message would be: "CFDs are complex instruments and come with a high risk of losing money rapidly due to leverage. 71% of retail investor accounts lose money when trading spread bets and CFDs with this provider. You should consider whether you understand how CFDs work, and whether you can afford to take the high risk of losing your money."

ESMA has specified that these risk warning messages must be prominently displayed in a font size equal to the predominant font size used on the website and in the same language as the rest of the communication or published information. However, in practice, it has been observed that these risk warning messages are often only displayed on the broker's website before trading occurs and not shown during the trading activity, particularly if the retail investor is using an external platform to place orders (such as the MetaTrader platform [3]).

Given the current market turmoil and the unprecedented volatility of cryptocurrencies (where CFDs are particularly common) (Hasso *et al.*, 2019), it is of interest to test whether displaying a risk warning message is truly effective in reducing the level of risk taken by investors and whether the placement of the message makes a difference.

To this end, we conduct an online laboratory study to investigate these questions.

2. Literature review

In this section, we provide a review of the existing literature on the three main topics our research focuses on: (1) the decision-making process of investors under risk, (2) dynamic inconsistency and (3) the role of information salience in shaping their risk-taking attitudes.

2.1 Individual decision-making under risk

Risk aversion has long been a central concept in the field of economics, and there have been multiple definitions proposed. Montesano (1985, 1986, 1988a, b) defines risk aversion as being directly linked to the size of the risk premium, or the difference between the expected value of an action and its certainty equivalent. Alternately, Chew *et al.* (1987), Machina (1987), Röell (1987) and Yaari (1987) propose that risk aversion is characterized by a decreasing preference for increasing risk. Both definitions are equivalent if a Von Neumann-Morgenstern utility function is assumed to exist.

In the financial market context, scholars often refer to risk tolerance. Financial risk tolerance (FRT) has been defined by Grable (2000) as "the maximum amount of uncertainty that someone is willing to accept when making a financial decision." Demographic parameters such as gender, age, education, income and occupation have been found to be influential in shaping an investor's FRT (MacCrimmon *et al.*, 1986; Riley and Victor Chow, 1992). Faff *et al.* (2008) also observed a strong alignment between risk aversion scores obtained from lottery-based experiments (such as Holt and Laury, 2002) and scores obtained from FRT questionnaires.

In terms of cognitive abilities, Dohmen *et al.* (2010) found that individuals with lower cognitive ability scores tend to display higher levels of risk aversion and impatience. These findings were significant and robust even when controlling for personal characteristics, educational attainment, income and measures of credit constraints.

2.2 Dynamic inconsistency

While dynamic consistency is a widely accepted concept in economics, some papers have suggested that it may not always apply to financial markets. For example, a paper by Froot and Obstfeld (1991) argues that financial markets may exhibit a degree of path-dependence, meaning that past decisions and events can have a lasting impact on future behavior. Similarly, a paper by Shiller (2003) argues that market volatility and bubbles can be driven by behavioral factors, such as herd mentality and irrational exuberance, which are not consistent with the principles of dynamic consistency. These papers suggest that while dynamic consistency may be a useful concept in certain contexts, it may not always accurately describe the behavior of financial markets, which are influenced by a complex interplay of economic, psychological and sociological factors. As such, policymakers and investors may need to adopt a more nuanced approach to financial decision-making, considering the unique characteristics of financial markets and the various factors that can influence them.

2.3 Information salience

With regards to the salience of information, it is well understood that attention is a limited cognitive resource that plays a significant role in economic decision-making (Simon, 1955). The salience of information, or the degree to which it stands out and captures attention, is therefore a crucial component in shaping decisions. Building on this understanding, Bordalo *et al.* (Bordalo *et al.*, 2012, 2013, 2016) proposed the 'Salience Theory' to assess the economic implications of how salience captures attention. According to this theory, the salience of a choice systematically impacts individual choices. This theory is based on two psychophysical concepts of perception, known as the Weber-Fechner law (Dzhafarov and Colonius, 2011).

Our research aims to expand upon previous literature by proposing to test the salience of information by introducing a financial risk warning message and having subjects participate in identical lotteries under different treatments. While literature on warning messages in economics is limited, it is well established in psychology, particularly in the context of gambling. For example, Gainsbury *et al.* (2015) found that informative and self-appraisal messages appear to facilitate responsible gambling by encouraging individuals to think about their time and money spent.

To measure the salience of information, we will vary the intensity of the warning message, moving from a one-time communication presented at the beginning of the lottery game to a repeated message presented across different steps of the risk elicitation task. This is expected to induce subjects to mitigate their risk-taking attitudes.

3. Experimental design and hypotheses set

3.1 The risk elicitation task

In this section, we provide a detailed overview of the experimental framework and treatments used in our research. As previously mentioned, our main objective is to investigate whether displaying a financial risk warning message can effectively reduce the level of risk taken by individuals and whether the placement of the message makes a difference. To achieve this goal, we have designed an online experimental setup that includes a list of 10 pair-wise lottery choices (as shown in the table below).

With regards to measuring individual's risk attitudes, Holt and Laury's (2002) approach has become the standard in economic experiments, due to its ease of implementation. This method is widely used and well established in literature, as it allows for a clear and efficient way of eliciting and interpreting subjects' risk aversion (see Table 1).

The 10 lottery choice pairs, which were presented one at a time during the experiment, were displayed as shown in Figure 1. The layout of the lottery choices was designed to be easily understood and visually appealing, drawing inspiration from Zhou and Hey (2018) by using a graph area that varies with probability and pay-off. This format was chosen for its ability to convey the information quickly and easily to the participants(see Figure 2).

According to Holt and Laury (2002), individuals who are risk neutral would choose lottery A for the first four pairs and then switch to lottery B for the fifth choice (from lottery 5 onwards, the expected value of lottery B is higher) without returning to lottery A. Individuals who switch to lottery B earlier are considered relatively risk-loving (they prefer a possible higher win of 96.25), while those who switch later are considered relatively risk-averse (they prefer a lower but safer win). The number of times an individual chooses lottery A, also known as safe choices, is associated with a constant relative risk aversion (CRRA or simply r) parameter (see Table 2).

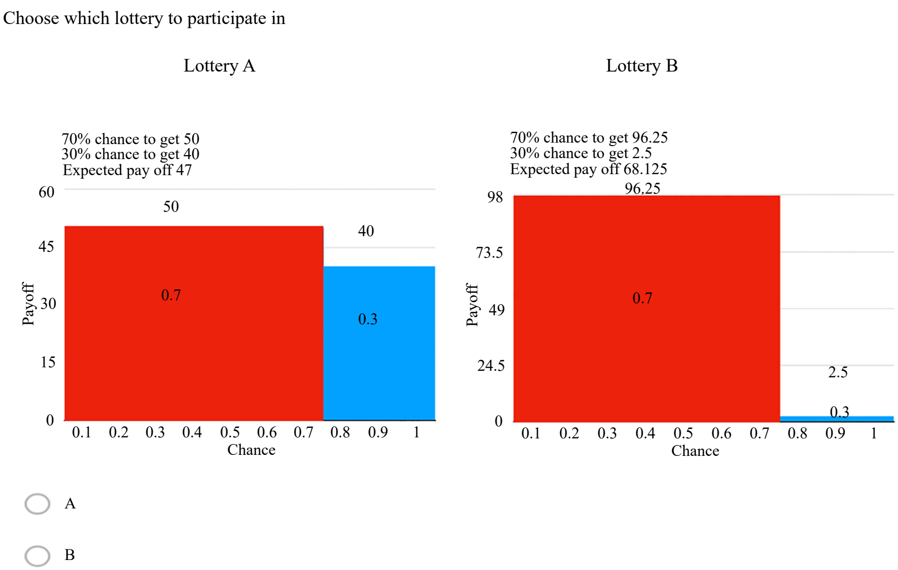
3.2 Experimental settings

The experiment was conducted online on May 18th and 19th, 2021. The sample consisted of 177 undergraduate students from the Faculty of Business at the University of Bari.

Lottery A		Lottery B	
50 ECU	40 ECU	96.25 ECU	2.5 ECU
10%	90%	10%	90%
20%	80%	20%	80%
30%	70%	30%	70%
40%	60%	40%	60%
50%	50%	50%	50%
60%	40%	60%	40%
70%	30%	70%	30%
80%	20%	80%	20%
90%	10%	90%	10%
100%	0%	100%	0%

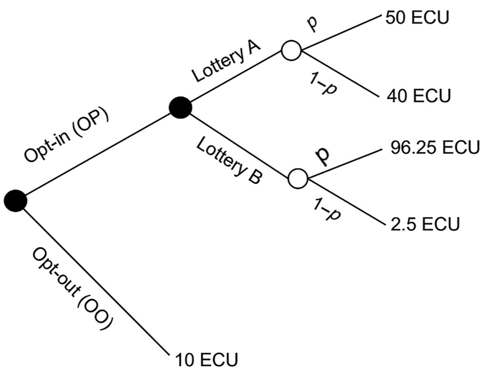
Source(s): Authors' own creation/work

Table 1.
Scheme of the 10 lottery choice pairs



Source(s): Author's own creation/work

Figure 1. Screenshot of the graphical representation of the lottery pay-off included in the questionnaire



Source(s): Author's own creation/work

Figure 2. Lottery schematic representation

The completion time (see Supplementary material) was recorded for each participant, to detect any abnormally short completion times (indicating impatience) or abnormally long completion times (indicating distraction or lack of interest).

To test the effectiveness of a warning message (measured by the CRRA parameter), the same 10 lottery choice pairs were presented under 3 different experimental treatments. Each participant was assigned to only one treatment and participants were randomly assigned to treatments alphabetically by surname initial.

To assess for dynamic inconsistency at the beginning of the treatment, participants were asked whether they wanted to participate in the lotteries or take home the endowment. This is labeled as initial question.

Table 2.
Holt and Laury scheme (2002) adapted from Alexy *et al.* (2016)

Number of safe choices	r (min)	r (max)	Risk preference classification
0	<	−1.712820	Highly risk loving
1	−1.712820	−0.946837	Highly risk loving
2	−0.946837	−0.486575	Very risk loving
3	−0.486575	−0.142632	Risk loving
4	−0.142632	0.146363	Risk neutral
5	0.146363	0.411456	Slightly risk averse
6	0.411456	0.676180	Risk averse
7	0.676180	0.970581	Very risk averse
8	0.970581	1.368390	Highly risk averse
9	1.368390	<	Stay in bed
10	–	–	Non-applicable

Source(s): Authors' own creation/work

English Translation of the message: "You have a 10 ECU endowment. Do you wish to participate in the lotteries? If so, your earnings will be between 2.5 and 96.25 ECU, but you will give up the endowment. If you do not participate, you will receive the endowment."

For instance, the decision of some participants to opt for the endowment option instead of completing the lottery game in our study indicates dynamic inconsistency (it might indicate risk aversion in residual cases). To ensure that this was not due to ambiguity aversion, participants were given the option to withdraw from the lotteries at any point during the game, ensuring that they had all the necessary information to make an informed decision.

Individuals who exhibit dynamic inconsistency may be more likely to opt out of lotteries, even if they are not inherently risk-averse, due to changes in their preferences or circumstances. Thus, taking dynamic inconsistency into account is essential in understanding the factors that influence financial decision-making. For example, a dynamically inconsistent individual may avoid investing in the stock market because he/she fears that he/she may change his/her mind in the future and sell the investments at the wrong time, resulting in financial losses. Similarly, he/she may choose to hold onto cash rather than investing in a long-term savings account because of uncertainty about future financial needs and may regret not having access to cash.

Hammond's (1976) example of a drug addict further illustrates the concept of dynamic inconsistency.

An addict knows that if he/she takes a small dose at present time, in the future he/she will most likely take a larger, riskier dose rather than sticking to the same reduced amount. Connecting to this example, in our scenario a dynamically inconsistent agent is aware that if he/she participates in the lotteries he/she will develop a riskier behavior and will switch as some point from lottery A ("small dose" in the drug addict example) to lottery B ("large dose" in the drug addict example). Therefore he/she may opt out of participating in lotteries, even if partaking results in a higher payout and opting out is inconsistent with the expected value calculation (as demonstrated by the lottery representation below). Although it was not the main topic of our study, we find strong experimental evidence in support, which may be further explored in future research.

Participants who entered the game were involved in one of the three different treatments (Treatment 1 - Treatment 3). As previously mentioned, the information salience increases as we move from Treatment 1 to Treatment 3 (see Table 3).

After completing the lotteries in each treatment, participants were asked to complete a series of questionnaires in the following order: a 6-item FRT questionnaire, a question on perceived financial well-being and a 9-item cognitive ability test. The FRT questionnaire used was a translation in Italian of the one used by the financial advisory company Edward Jones for its clients [4]. This questionnaire was chosen for its simplicity, which requires no financial knowledge and its quick completion time. The cognitive ability questions were a translation in Italian of the numeracy and cognitive ability test used by Taylor (2013). The financial well-being question was a straightforward answer on a scale from 1 to 10, indicating the participant's perceived financial situation [5].

Participants were informed that at the end of the experiment, 10% of the sample would be randomly selected and one of the ten decisions would be used for payment (1 Experimental Currency Unit (ECU) = 0.1 €).

3.3 Research hypothesis

Following the existing theoretical studies on the salience of information, we can formulate the main working hypothesis as follow:

H1. More subjects will exit the risky lottery game in Treatment 3 than in Treatment 2 and more will exit in Treatment 2 than in Treatment 1

Psychological research on salience shows that salient stimuli draw human attention due to their contrast with surroundings, their surprising nature relative to past experiences, or their prominence (Bordalo *et al.*, 2022). Psychological research in the context of gambling if extended (even though the basis for extension if open to discussion) would support the hypothesis (Monaghan and Blaszczynski, 2010).

Specifically, we expect two different behaviors:

H1_1. If the warning message is effective, a greater part of subjects will exit the risky lottery games. Hence, we will observe a higher exit rate in Treatment 3.

H1_2. In Treatment 3 subjects participating to the lottery will more frequently (compared to Treatment 1 and Treatment 2) opt for the "safe option", reducing the risk propensity and then, the selection of the riskiest option.

As qualitative robustness check, we will control if our results are consistent with and contribute further to the existing literature on cognitive ability and financial tolerance.

In particular:

H2. FRT reflects the individual background propensity to assume risk.

This will be in line with all the existing studies relating the FRT and the broader definition of risk propensity (see section 2.1).

H3. Subjects with low cognitive ability scores display greater risk aversion

Despite alternative studies proposing the absence of a potential relationship (Andersson *et al.*, 2016, 2020), this would be in accordance with Dohmen *et al.* (2010) and with the theories of choice

Treatment #	Information salience	N of participants
1	None (only initial question shown prior to treatment)	46
2	Warning message shown just once prior to treatment start on the same screen as the initial question	53
3	Initial question shown prior to treatment. The warning message is displayed after each lottery choice, giving the subject the chance to reevaluate and change their decision after acknowledging the message	78

Source(s): Authors' own creation/work

Table 3. Summary of the three treatments

bracketing (Tversky and Kahneman, 1981; Read *et al.*, 1999). Here, some individuals may have trouble bracketing choices broadly, in other words in recognizing how single risky decisions integrate with other assets like lifetime wealth, or to conceptualize and factor in future considerations with current aims. The absence of this effect would be in line with who find that cognitive ability is related to random decision-making errors rather than to risk preferences.

Additionally, we conduct a qualitative check to identify individuals who switch back and forth between lottery choices A or B, commonly referred to as "multiple switchers." Despite its widespread adoption, a practical limitation of Holt & Laury approaches is the number of individuals who switch back and forth, which deviates from typical expectations of preferences (Charness *et al.*, 2013). Multiple-switching behavior (MSB) is typically considered poor decision-making, although some studies suggest that MSB may indicate indifference among a variety of options (Andersen *et al.*, 2006).

In our study, we investigate the relationship between MSB, cognitive ability and effort (treatment completion time). For example, multiple switchers may not correctly understand the elicitation methodology or provide inconsistent answers (Lévy-Garboua *et al.*, 2012). Dave *et al.* (2010) suggest that cognitive ability plays a role in understanding the multiple-price list (MPL). Furthermore, boredom and a lack of effort can also contribute to switching behavior (Lévy-Garboua *et al.*, 2012; Bauermeister and Mußhoff, 2019). Taking these factors into consideration, we attempt to understand the existence of multiple switchers based on (1) the effort used to complete the task, as proxied by the completion time and (2) their level of comprehension, as proxied by cognitive abilities. The latter variable has been well-studied and used in previous research to profile multiple switchers, while extremely low (or high) completion time may indicate individuals answering randomly in a few seconds or taking an unreasonable amount of time to complete the task. As we will observe in the next section, this approach is promising in identifying MSB.

4. Results

We recruited 20-year-old economics students for our sample, which is predominantly composed of women (56%). In terms of our variables of interest, cognitive abilities (average = 5.67), FRT (average = 43.35) and financial well-being (average = 6.27) did not show any statistical significance across groups. This leads us to conclude that the three subsamples are homogeneous. The average completion time was around 36 min.

As preliminary results, the exit rate varies among the three treatments: 19.5% in Treatment 1, 18.5% in Treatment 2 and 38.5% in Treatment 3. The findings suggest that participants who exhibit dynamic inconsistency, are more likely to withdraw from the lotteries in Treatment 3 (Hey and Panaccione, 2011), supporting our first set of hypotheses.

We performed a test of proportions, as shown below, which demonstrated a statistically significant difference in the exit rate between Treatment 3 and the other treatment groups. There was no statistically significant difference found between Treatment 1 and Treatment 2 (see Table 4).

To further analyze this effect, we included a probit model in our analysis, using the individual exit option as the dependent variable. The results of this analysis can be found in Table 5.

As can be observed, the only factor impacting the exit rate choice is the information effect, as all control variables are not statistically significant. This highlights the significant impact that information has in reducing risk, as posited in our theoretical framework.

To further analyze the decrease in risk propensity, it is worthwhile to examine how lottery participants handle risky decisions. Figure 3 provides an overview of the risk aversion rate (calculated as the number of subjects selecting the safe option A for each decision problem). It is clear that risk aversion is higher in Treatment 3, as the relative line is consistently above the others. This result is also confirmed by a Kolmogorov-Smirnov test.

As an additional empirical analysis, we perform an interval regression model (Table 6), using the lower and upper limits of the CRRA interval corresponding to the switch from lottery A to B as the dependent variable. This is a commonly used strategy for analyzing Holt and Laury's (2020) outcomes (as seen in Caferra *et al.*, 2021). We control for other subject characteristics such as gender and income, while also examining the correlation between FRT and cognitive abilities, as previously discussed in the literature review.

Before running the interval regression model, we further investigate MSB and perform a K sample equality of the medians test (Table 7) showing a statistically significant difference between the treatments.

As shown in the above table that there are 6 multiple switchers in Treatment 1, 11 in Treatment 2 and 25 in Treatment 3. Consequently, we propose several versions of the model to explain its presence. We use cognitive ability as a baseline variable and consider individuals with a score lower than 3 as those who may have difficulties in clearly defining their risk preferences due to difficulties in understanding the task. Additionally, we use completion time as a proxy for effort and consider two different thresholds of low/high completion time (1ST decile/10th decile of completion time) as a robustness check.

When considering only the low threshold of cognitive abilities, we can identify 6 multiple switchers (MSs), 2 per each treatment. Using the high threshold of completion time (HTMS), we find 1 multiple switchers in Treatment 1, 4 in Treatment 2 and 9 in Treatment 3. Adding to the model the low threshold of completion time (LTMS), the number increases to 5 subjects in Treatment 1, 7 subjects in Treatment 2 and 17 subjects in Treatment 3.

Table 4. Test on proportions. Exit rate as dependent variable

Two sample test of proportions Difference	Treatment 1 (mean 0.195)	Treatment 2 (mean 0.188)	Treatment 3 (mean 0.384)
Treatment 1		0.006	−0.188***
Treatment 2			−0.195***

Note(s): *** statistically significant
Source(s): Authors' own creation/work

Table 5. Probit Model: exit rate as dependent variable

	(1) Baseline	(2) Margins	(3) Full	(4) Margins
Treatment 2	−0.026	−0.007	−0.032	−0.009
	(0.291)	(0.08)	(0.292)	(0.079)
Treatment 3	0.564**	0.189**	0.572**	0.191**
	(0.257)	(0.081)	(0.26)	(0.081)
Male			0.044	0.014
			(0.207)	(0.066)
Fin. Risk Tol. Score			−0.001	0
			(0.007)	(0.002)
Financial Well-being			−0.051	−0.016
			(0.069)	(0.022)
Cognitive Ability			0.007	0.002
			(0.052)	(0.017)
Constant	−0.857***		0.575	
	(0.212)		(0.627)	
Observations	177	177	177	177
Pseudo R^2	0.039		0.042	

Source(s): Authors' own creation/work

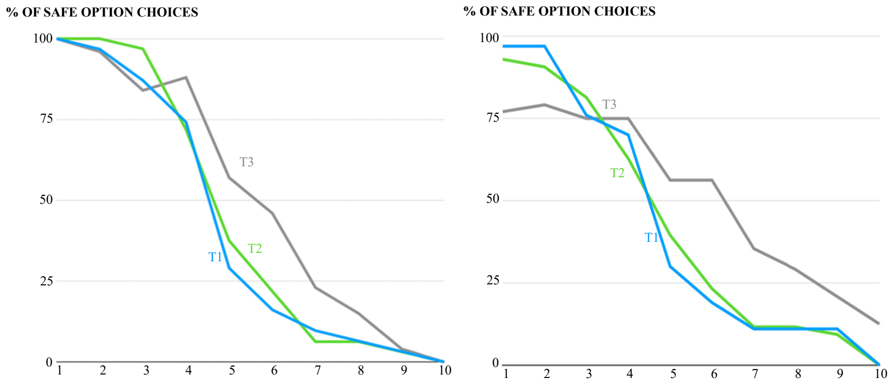


Figure 3.
Fraction of the safe option choice across the three treatments (T1, T2 and T3)

Note(s): Percentage of safe option (Lottery A) choices on the y-axis for each decision problem (x-axis). With the inclusion of multiple switchers on left, without multiple switchers on right. Data from all observations without further processing
Source(s): Author's own creation/work

Table 6.
Interval regression model (Risk): risk-aversion interval as dependent variable

	(1) Baseline-NoMS	(2) Full-NoMS	(3) Full-LTMS	(4) Full-HTMS	(5) Full
Treatment 2	0.002	−0.004	0.014	0.007	0.006
	(0.116)	(0.109)	(0.107)	(0.102)	(0.1)
Treatment 3	0.262**	0.277**	0.384***	0.352***	0.232**
	(0.128)	(0.12)	(0.121)	(0.11)	(0.105)
Male		0.103	0.166*	0.151*	0.17**
		(0.091)	(0.092)	(0.088)	(0.086)
Fin. Risk Tol. Score		−0.009***	−0.007**	−0.006*	−0.006**
		(0.003)	(0.003)	(0.003)	(0.003)
Financial Well-being		−0.007	0	−0.007	−0.002
		(0.033)	(0.032)	(0.03)	(0.029)
Cognitive Ability		−0.042*	−0.028	−0.027	−0.008
		(0.022)	(0.023)	(0.023)	(0.022)
Constant	0.111	0.721**	0.434	0.449	0.344
	(0.086)	(0.281)	(0.296)	(0.277)	(0.27)
Observations	86	86	107	118	122
Log-likelihood	−153.453	−148.366	−190.576	−210.753	−217.428

Source(s): Authors' own creation/work

Table 7.
K sample equality of the medians test

Median test		Treatment		
Greater than the median	1	2	3	Total
No	31	32	23	86
Yes	6	11	25	42
Total	37	43	48	128
Pearson $\chi^2(2) = 13.7282$	Pr = 0.001			

Source(s): Authors' own creation/work

We also discard 6 multiple switchers that fail the rationality test, as in the last decision problem, lottery B has a higher reward as a certain value, hence it is completely irrational to opt for lottery A.

Therefore, we fail to categorize only 1 multiple switcher in Treatment 1, 4 in Treatment 2 and 5 in Treatment 3. These individuals may have biased or non-constant preferences due to lack of effort or low levels of task comprehension. However, it is also possible that their preferences are simply non-constant or that they have an erratic behavior due to other out-of-control circumstances.

The findings confirm the evidence presented in Figure 3, which shows that the risk-aversion parameter is higher in Treatment 3, where the information is both salient and substantial. When considering other variables, we observe a positive correlation between financial risk attitude and general risk attitude as demonstrated by our experiment. This consistency supports the validity of the data collected. We also considered different model specifications, including those for long-term decision makers (LTMSs) and erratic decision makers (defined as those whose residual decision-making styles do not fall into the previous categories). In these cases, we determined the risk interval by using the lower and upper limits of their first and last switch, respectively. However, regardless of these considerations, the statistical significance of the estimation remains unchanged.

We can summarize the results of the three hypotheses as follow:

R1. In Treatment 3, where the intensity of the warning message is higher, more subjects exit the risky lottery game in Treatment 3 than in Treatment 2 and more will exit in Treatment 2 than in Treatment 1

As suggested in Van Schie and Van Der Pligt (1995), framing and salience are prominent in influencing risky decision. In this case, it turns successful in mitigating individual risk propensity.

R1.1. A greater part of subjects will exit the risky lottery games, resulting in a higher exit rate in Treatment 3.

R1.2. Subjects participating to the lottery opt for the "safe option" more frequently in treatment 3 compared to treatment 1 and 2.

The hypothesis is supported by both empirical findings, indicating that participants display dynamic inconsistency and tend to choose a certain value (i.e. the initial endowment) more frequently in Treatment 3 than in Treatment 1 and Treatment 2. Additionally, the warning message appears to persuade participants engaged in lotteries to reduce their risk propensity.

Regarding the impact of the one-shot message in Treatment 2, it seems insufficient to change the behavior of participants. However, the repetition of the same signal has a significant influence on decision-makers' mindset.

R2. FRT reflects the individual background propensity to assume risk.

Similarly, to Faff *et al.* (2008), we observe that risk aversion scores obtained from lottery-based experiments is correlated with those obtained from FRT questionnaires. Specifically, higher risk propensity is consistent with higher FRT.

R3. Subjects with low cognitive ability scores display greater risk aversion

We provide (weak) statistical evidence supporting the relationship between cognitive abilities and risk preferences. In particular, we observe that individuals with low levels of cognitive abilities lead to higher risk aversion. This might be probably associated with higher prudence due to the difficulties in properly quantifying the risk related to each task.

R4. MSB is (partially) proxied by Cognitive abilities and effort variables.

Low cognitive abilities are powerful in predicting MSB. As in Andersson *et al.* (2020), cognitive abilities are more likely to explain bias in preferences rather than robust risk attitudes. Furthermore, boredom and lack of effort figure out switching behavior (Lévy-Garboua *et al.*, 2012; Bauermeister and Mußhoff, 2019).

To conclude, we present the results of a probit regression model in which the dependent variable is MSB (Table 8).

The results indicate that individuals with lower cognitive ability are more likely to be multiple switchers, which means they frequently change their preferences. This finding is in line with existing research in psychology and behavioral economics, which suggests that people with lower cognitive ability may face difficulties in decision-making and commitment. One possible explanation for this relationship is that people with lower cognitive ability may have limited capacity for processing information, making it challenging for them to evaluate the pros and cons of different options. They may also struggle to anticipate the outcomes of their decisions, leading to more second-guessing and a greater likelihood of changing their preferences.

5. Discussion and conclusions

Risk is widely acknowledged as fundamental principles in economic theory, with financial decisions being particularly influenced by individuals' risk perceptions and attitudes. In response to this, in 2018, the European Securities and Markets Authority (ESMA) mandated the inclusion of a standardized risk warning for retail investors engaging in trading activities on CFDs and binary options. However, this warning is often only displayed on the broker's website prior to trading and not during the trading activity itself.

To evaluate the effectiveness of this approach, we conducted an online experimental study. Using a pair-wise lottery choice risk elicitation task, we tested for any differences in recorded behavior and displayed risk aversion when no risk warning was present, when a warning was present before the lottery choice activity and when a warning was shown after every single lottery choice, giving subjects the option to reconsider their choice. Additionally, as a robustness check, we assessed FRT through a questionnaire-based task and cognitive abilities to examine any relationship between these factors and the results of the risk elicitation task.

Our analysis indicates that displaying a message after every single choice is taken is the most effective method for reducing risk-taking (as the number of safe choices is higher in

	(1) Baseline	(2) Margins	(3) Full	(4) Margins
Treatment 2	0.309	0.077	−0.393	−0.086
	(0.305)	(0.075)	(0.2323)	(0.07)
Treatment 3	0.658**	0.19***	0.801***	0.206***
	(0.278)	(0.073)	(0.295)	(0.068)
Male			−0.452**	−0.012**
			(0.229)	(0.059)
Fin. Risk Tol. Score			0.008	0.002
			(0.007)	(0.002)
Financial Well-being			0.128*	−0.034*
			(0.073)	(0.019)
Cognitive Ability			−0.191***	0.051***
			(0.065)	(0.016)
Constant	−1.124**		−1.173*	
	(0.235)		(0.712)	
Observations	177	177	177	177
Pseudo R^2	0.033		0.129	

Source(s): Authors' own creation/work

Table 8. Probit model: multiple switching behavior as dependent variable

Treatment 3 than Treatment 1 and Treatment 2), with very little difference between the treatments of no message and a message shown just once. This is consistent with research by which suggests that framing and salience are influential factors in decision-making under risk. We also report a larger exit rate from the lottery game in Treatment 3 (38.5%) compared to Treatment 1 and Treatment 2 due to potentially dynamically inconsistent subjects. For instance, dynamic inconsistency is an emerging corollary to our study. It is suggested by our results and could be subject for further investigation in future studies.

Our findings also align with established literature by Faff *et al.* (2008) that suggests that risk scores obtained through lottery choice tasks and FRT questionnaires are highly comparable. Additionally, we provide statistical evidence supporting a relationship between cognitive abilities and risk preferences, with individuals with low cognitive abilities scores displaying greater risk aversion. This may be attributed to higher prudence resulting from difficulties in accurately assessing risk.

Our research offers valuable insights for designing effective risk reduction policies that focus on information prominence and salience and may be applicable to a range of risk-taking activities beyond the financial market. To the best of our knowledge, our study is the first to simulate investment decisions in a simplified online laboratory task while also evaluating the salience of risk warning messages and assessing cognitive ability and questionnaire-based risk aversion. Our easy-to-replicate, cost-effective framework could encourage further research in this area.

Future studies could replicate this setup using subjects who have engaged in trading activity in the past 6 months, as undergraduate students are unlikely to have done so. This would extend the literature on the external validity of experiments (Guala and Mittone, 2005). However, as discussed in several papers (see, among others, Caferra *et al.*, 2021), the “typical subjects’ pool” might be representative of real-life professional traders’ behavior under risk, validating the strength of our results.

It would also be interesting to report our laboratory setting in a real-life context, checking whether online brokers observed a dip in trading activity or less risk taking by investors after the introduction of the risk warning message on their website, even though the data is confidential, this task would be very difficult to conduct.

Notes

1. http://safefrankfurt.de/fileadmin/user_upload/editor_common/Policy_Center/Gomber_Pierron_MiFID_report.pdf
2. https://www.esma.europa.eu/sites/default/files/library/esma35-43-1912_cfd_renewal_3_-_notice_en.pdf
3. https://www.metatrader4.com
4. https://www.edwardjones.com/sites/default/files/acquiadam/2021-02/risk-tolerance-questionnaire.pdf
5. Full transcript of the experiment and questionnarie translated to English can be found here https://forms.gle/91CJ7nK4P8e1DsSB6.

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Supplementary material

The supplementary material for this article can be found online.

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