INVESTORS DECISION MAKING: THE INTERACTION OF ENVIRONMENTAL FACTORS AND INDIVIDUAL TRAITS

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Abstract

Our study extends prior research on the investment decision making process developing an investor cognitive model with three stages to investigate the driving factors of investors' decisions and providing empirical evidence on the interaction between environmental factors and individual traits on investors' decision making. We test the empirical predictions of our model with an experiment on a takeover bid. Our results show that: a) high ambiguity context influences negatively the three phases of the decision making model, b) the interaction of cognitive profile with context ambiguity and information clarity determines individuals' noticing and sensemaking, c) the reliability of the source is the least relevant variable on noticing, d) cognitive profile interacts with ambiguity, information clarity and reliability of the source to influence investors action e) proactivity is the most relevant cognitive characteristic in the action phase, specially when the stimulus has not been noticed.

Keywords: ambiguity, clarity of information, reliability of source, cognitive profile, decision, takeover bid.

JEL: D83, G14, G34

1. Introduction

The literature considers that the black box of the financial market is the investors' information processing, since it contains the key factors of the decisions they make (Mahmood et al, 2011). Behavioral finance emphasize that opening that black box will allow explaining the inefficiencies observed in financial markets but not predicted by the Efficient Markets Hypothesis (EMH). This knowledge will allow defining strategies or behaviors for reducing the gap between actual markets and efficient markets. The study of the decision making process is considered relevant not only to explain the dynamics of financial markets but also to help financial advisors to develop their prescriptive activity of advising in a more effective way (Kahneman and Riepe, 1998)

Our study extends prior research on the investment decision making process developing an investor cognitive model with three stages to investigate the driving factors of investors' decisions and providing empirical evidence on the interaction between environmental factors and individual traits on this process. To our knowledge, the interaction of the particular variables we consider has not been previously studied in the financial literature as a determinant of investor's decisions. Our environmental variables are ambiguity, clarity of the informative stimulus and reliability of the source of information. The individual cognitive profile is depicted by the cognitive style, ambiguity tolerance and proactivity.

Financial decisions are compelled and constrained by non-financial factors. These include context factors as well as personality characteristics of individuals, these moderating the way in which the environment affects decisions (Holden, 2010). Among the environmental factors that influence investors' decisions, information plays an essential role. Investors make up their mind regarding the uncertainties involved in any investment based on the information they receive from different sources (Mahmood et al., 2011). Moreover, De Bondt and Thaler (1994) argue in their path breaking paper that it is indispensable to consider psychological variables and processes when approaching the market. In the same vein, Statman (1999) denies that behavioral finance introduced psychology into finance, since psychology was never out of finance. Finally, Oberlechner and Hocking (2004) state that psychologically informed empirical research may contribute to a better understanding of actual information processing in markets by considering attitudes of market participants and examining the role of the sources of information and their influence on investors.

Previous literature demonstrates the arousal of differential information processing among individuals. This evidence reveals that it is difficult to identify the individual characteristics driving this process. Maybe, this is the reason why, in the literature, the individual characteristics have often been represented by demographic variables such as age, sex, qualifications and experience[1]. Nevertheless, the impact of these demographic variables is usually explained by appealing to cognitive aspects and different attitudes. Therefore, we consider more appropriate to introduce in the model the cognitive variables and the individual attitudes directly and not by means of demographic variables (Santos et al., 2011).

Our cognitive model incorporates three stages: noticing, sensemaking, and action. It takes into account that processes such as perception and action are commonly included in cognitive models (Lovric et al., 2008) and integrates the arguments of Starbuck and Milliken (1988) about dividing perception into noticing and sensemaking. We identify some variables that explain how investors notice some news but ignore others, interpret the news they notice in a particular way, and finally make a certain decision.

In sum, in this paper we analyze how some characteristics of the information –ambiguity, clarity and reliability of the source- and the decision-maker's cognitive profile –cognitive style, ambiguity tolerance and proactivity- interact in each one of the phases for investment decision making. To do so, in a controlled way, we develop an experiment.

In the following section, we present our investor cognitive model. Section three introduces the interacting factors in the cognitive model and the hypotheses to contrast. Section four describes in detail the experiment we have conducted. Finally, section five presents our empirical results and section six discusses the main implications of our study.

2. Investor cognitive model

García-Ayuso and Jiménez (1996) argue that research on financial decision making can be conducted by means of cognitive models. Lovric et al. (2008) showed that processes such as perception and action are commonly included in cognitive models (Eg., Sloman, 2001; Warren, 2006).

Perception is the cognitive process by which individuals gather information and create an image of their surrounding reality. Such perception generates an imperfect awareness of reality. Thus, from

[1]See, among others, Powell and Ansic (1997), Robert and Cox (2001), Tutek et al. (2010) and Santos and Barros (2011).

the same informative stimulus, one can find that two individuals perceive different realities (Fahey and Narayanan, 1989). The literature has stressed the diversity of factors that influence and intervene in the perception process. Besides, the perception process includes several phases. In particular, perception process can be divided into two stages (Starbuck and Milliken, 1988): the first one is noticing where the individual distinguishes signals (relevant information) from noises (irrelevant information), whereas the second is sensemaking where the individual interprets those stimuli previously considered as signals.

Our model integrates these proposals to define a cognitive model of investors' decision-making with three stages: noticing, sensemaking, and action. Oberlechner and Hocking (2004) find that financial markets may be less about the actuality of economic facts than about how information is noticed and interpreted by market participants and emphasize the relevance of market participants' attitudes on information processing.

Noticing is a key element in a decision making model because, as Starbuck (1988) argues, those individuals unable to notice relevant changes will find difficulties to comply with their goals. Such difficulties will arise either because the individual will not modify properly the way they use their knowledge or because they have not recognized the need of further improvement in their knowledge.

Karlsson et al. (2005) study investors' selective attention, i.e., the capacity to attend to or ignore information. In other words, the authors look at the individuals' capacity to consider the stimuli as signals or noises.

Once the stimuli have been noticed and the investor has differentiated between noises and signals, the individual makes sense of the signals noticed. As was the case in noticing, not all investors interpret relevant information in the same way (Starbuck and Milliken, 1988; Braunstein and Welch, 2002; Santos and Barros, 2011) due to individual traits.

Finally, action occurs when an investor changes their current portfolio (Lovric et al., 2008). According to these authors, the action phase includes decisions about which asset to choose, the amount of the asset to trade, the type of order sent to the market and the rest of parameters required to complete the order.

3. Interacting factors: environment variables and individual traits

There are many papers that focus on the main factors influencing the investment decision making process. Some of these papers concentrate on the effect that some environment characteristics have on decision making whereas others deepen in the analysis by recognizing that the attitudes and cognitive profile of investors are moderating factors of the way environment affects decision making. Our goal is to shed light on this item by identifying the driving factors of investors' decisions and providing empirical evidence on the interaction between environmental factors and individual traits on this process.

In this section we introduce the environment factors: ambiguity, information clarity and source reliability; and the investor cognitive profile: cognitive style, tolerance ambiguity and proactivity considered as moderating factors to empirically test the interactions between environment and cognitive profile on our investor decision making model.

The evidence shows that the individual cognitive profile has a role in the different phases of the investor decision making model. In our case, the model chosen includes three phases. Thus, it has been argued that emotions, education, genetics (Barnea et al., 2010) and the social environment influence in shaping not just what but how information is interpreted and financial decisions are made (Braunstein and Welch, 2002).

The first characteristic of the investor cognitive profile considered is cognitive style. Cognitive style is the way chosen by an individual to process and evaluate information. Thus, cognitive style affects the way individuals explore their environment to collect information, how they integrate the interpretations that they do by using mental models and subjective theories (Hayes and Allinson, 1998) and how they use such information to guide their behavior. In our paper we have chosen the bipolar scale proposed by Allinson and Hayes (1996). This scale classifies individuals into two groups: analyst and intuitive. Analyst individuals study in detail the problems and make decisions based on mental reasoning, whereas intuitive individuals base their decisions on sentiments. For instance, to identify investors behavior, Shiller and Pound (1989) consider if the individuals analyze or not on their own the financial information on stocks before buying them. Analyst individuals are more prone to analyze information before making a decision than intuitive ones.

The second characteristic of the cognitive profile considered is ambiguity tolerance. This characteristic measures the way an individual perceive and process information about ambiguous stimuli or situations, or the way an individual face complex, incongruent or unfamiliar data.

Ambiguity tolerance is measured with an unidimensional scale. Those individuals with low ambiguity tolerance consider ambiguous situations as threats and, as a consequence, they prefer not to act under risky or uncertain conditions (Sully de Luque and Sommer, 2000; Ling et al., 2005). On the other hand, those individuals with high ambiguity tolerance accept that uncertain situations can change quickly and unexpectedly and that available information can be confusing, complex and/or inadequate (McNally et al., 2009). Therefore, investors with high ambiguity tolerance show more capacity to make decisions in risky situations or in uncertain environments.

Ghosh and Ray (1997) find that the role of risk tolerance and ambiguity tolerance in decision making depends on the risk and ambiguity levels. They also find that both cognitive traits determine the individuals' behavior in the decision making process. In the same vein, we consider ambiguity tolerance as a key variable of individual behavior to analyze the influence of ambiguity on decision making.

The last cognitive profile characteristic considered is proactivity. Proactive personality is considered a stable disposition to take personal initiative in a broad range of activities and situations (Seibert et al., 2001). Proactive individuals look for opportunities, show initiative, are entrepreneurs and persevere until the achievement of their goals. The proactive behavior is anticipatory and looks for future benefits; hence, proactive individuals are motivated to process information (Grant and Ashford, 2008). Finally, proactive individuals are less affected by the stimuli from the environment than reactive individuals (Kickul and Gundry, 2002; Zaleznik, 1977). Therefore, proactivity is a key variable in decision making, especially in the last stage of our cognitive model: action.

Once we have described the cognitive profile factors to be considered in our paper we proceed to introduce the environment factors.

Ambiguity is a key factor in financial markets. An ambiguous scenario takes place when the decision-maker doubts about what it is going to happen and does not have information enough to estimate the probability distribution of the different outcomes of future events (Frisch and Baron, 1988; Ghosh and Ray, 1997). Ambiguity influences decision making differently as it does risk, because risk, according with the classic finance theory, can be measured using the probability distribution that it is considered known (Ellsberg, 1961; Ghosh and Ray, 1997). Arnold et al. (2010) distinguish soft information from hard information. Soft or ambiguous information, unlike hard or less ambiguous information, is not numerical and can be interpreted in several ways. They show that soft information influences investors' portfolio choices.

Epstein and Schneider (2007), Garlappi et al. (2007), and Epstein and Schneider (2008) analyze how ambiguity embedded in information on investments returns affects portfolio composition. News reducing ambiguity may be good and raise portfolio weights or bad and decrease portfolio weights. Hence, a decrease in ambiguity has a positive impact in trading. Some authors analyze the impact of ambiguity only on sensemaking. Ahmed et al. (2009) show empirically that the quality of the information issued by the market moderates the discrepancies among agents to interpret such information.

However, such analyses don't take into account the individual cognitive profile. In contrast, Ellsberg (1961), Einhorn and Hogarth (1985) or Ghosh and Ray (1997) among others, have studied how ambiguity and risk influence investment decision making as a function of some investors traits, e.g. conservatism, preferences, ambiguity tolerance, level of confidence.

In order to analyze the impact of ambiguity on the three phases of our decision making model, our paper considers each stimulus in two scenarios: one of low ambiguity and the other of high ambiguity. We propose hypotheses 1 and 2 to test the effect of ambiguity.

Mischel (1973) finds empirical evidence of the impact of clarity on decision making. He distinguishes strong from weak situations[2]. Weak situations have diffuse meanings such that two individuals could interpret in a different way the same event. Furthermore, there is a high probability that those two individuals will react differently to that event. Specifically, Allport and Postman (1947) consider that rumors are characterized by doubt as they are unaccompanied by the "secure standards of evidence". DiFonzo and Bordia (1997) study the link between rumors and behavior in the stock market. They argue that in such highly uncertain environments as financial markets, rumors play an important sense making role.

Bruner (1957) argues that as the stimulus becomes more complex and ambiguous the individual perception will depend more on what it is in the individual and less on what it is in the stimulus. Then, the interaction among individual cognitive profile, ambiguity and information clarity will influence the two phases of perception: noticing and sensemaking. We consider clear and unclear stimuli to test these interactions stated on hypothesis 3.

[2] Situational strength is related to what researchers on social cognition know as stimulus "prominence" (Fiske and Taylor, 1991). A stimulus is prominent when it has some properties that increase the probability of the stimulus being perceived.

Our third context factor is the reliability of the source of information. The relevance of this factor in investment decision making has been widely studied[3]. The most common and cheap source of information for an investor are newspapers, either specialized in financial news or not, but there are other sources of information that the investor can rely on, as for instance conversations with other investors or agents participating in the financial markets (Lovric et al., 2008). All of them play an essential role by disseminating information in financial markets (Oberlechner and Hocking, 2004).

Some have studied its impact on noticing. Thayer (2011) shows that, despite of the fact that investors generally choose sources of information based on its reliability, they forgo this reliability to confirm the adequacy of their investment positions. In the same vein, Oberlechner and Hocking (2004) showed that market participants consider reliability of the source of information less important than its speed. Therefore, the reliability of the source of information is relevant in noticing when it interacts with other variables.

Some others have emphasized its impact on action. Lovric et al (2008) consider driving factors of action: a trading strategy, peer influence, a habit, or an emotional response to financial news or price changes. These authors also recognize that contagion of behaviors by means of the different sources of information has also an important role on action. Gleason and Lee (2003) show that investors reaction to forecast made by famous analysts are faster than to those made by lesser-known analysts. Finally, Shiller and Pound (1989) studied the relevance of the conversations among agents in the market on investment decision making. They found that the individual investors who bought an asset they did so because such asset get their attention after their conversations with other investors. In our paper we classify the sources of information as reliable or non-reliable. Hypotheses 4 and 5 are designed to test the impact of the reliability of the sources on investment decisions.

Then, the hypotheses of our paper can be summarized as follows,

H1: Ambiguity affects negatively the three stages of the decision making process: noticing, sensemaking and action.

H2: The individual cognitive profile moderates the influence of ambiguity on the three stages of the decision making process.

[3] See, among others, Oberlechner and Hocking (2004), Lovric et al. (2008), Tutek et al. (2010).

H3: The interaction among the individual cognitive profile, ambiguity and clarity has an impact on noticing and sensemaking.

H4: The reliability of the source of information only has an effect on noticing when it interacts with other context variables and the cognitive profile affects this influence.

H5: Individual cognitive profile interacts with ambiguity, information clarity and reliability of the source to influence investors' action.

H6: When the stimulus has not been noticed, proactivity affects positively on action.

4. Experimental design and variables

We develop an experiment to investigate the driving factors of investors' decisions and provide empirical evidence on the interaction between environmental factors and individual traits on the stages of the information processing model we propose. In the experiment, after identifying the individuals' cognitive profile by means of several questionnaires, participants were asked to carry out a decision task.

The experiment was administered through the use of three documents. The first one described the experimental design, the task and the payments. The second document was a questionnaire to measure participants' cognitive profile: their analyst/intuitive style, ambiguity tolerance, and proactivity. The analyst/intuitive style was measured using Allinson and Hayes (1996) Cognitive Style Index (CSI). This instrument consists of 38 statements[4], each rated using a 3-point scale (true; uncertain; false). The range of scores runs from 0 to 76. Individuals with an analytical style obtain high scores on the CSI, while intuitive individuals get low scores. The Cronbach alpha for this scale is 0,857, so its internal consistency can be considered satisfactory. Four statements initially proposed by Losch and Morse (1974) and adapted by Westerberg et al. (1997) were used to test tolerance for ambiguity. Acedo and Jones (2007) report a 0,76 composite reliability for the measure. Finally, proactivity was assessed with a 10-item scale developed by Seibert et al. (1999) with alpha reliability 0,88. All items of the ambiguity tolerance and proactivity scales were measured on a 5-point Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree". More information and the items used can be found in the Appendix.

[4] Some authors propose to divide CSI into two scales (see Hodgkinson and Sadler-Smith (2003) among others), one to measure analysis and the other to measure intuition. Then, we have run all the analyses either with one scale for CSI or with two. The results using two scales for CSI confirm the results using one scale for CSI.

After the questionnaire, participants were given the third document with the task setting. In 12 different situations with information on a possible takeover bid (TOB) announcement, participants answered two questions for the target firm and the same two questions for the bidder. Hence, for each company involved in the TOB, they have to indicate first, whether they think that in the short term the information will have an impact on the share price of the company (noticing) and if so, if the price will rise or fall (sensemaking). Second, assuming they own shares of the company, they have to decide to buy, sell or do nothing (action). Thus, regarding the noticing step, we identify the participants consider the stimulus as a noise when they answer that the share price will remain unchanged and as a signal otherwise (rise or fall). The sensemaking step's result is given by the signal interpretation, positive when answering that the share price will rise and negative otherwise. On the other hand, the answer to the second question in each situation reflects the decision made in the third step of the model, action. Participants were told that they were going to be rewarded on the basis of the rationality of their decisions.

Bruner (1957) argues that the more complex and ambiguous a stimulus is, the more relevant individual traits are in the decision making process. Thus, in our paper to reproduce different levels of complexity, we design 12 scenarios where participants are provided with information about the possibility of a forthcoming TOB announcement, but not the TOB announcement itself.

We choose a TOB to analyze individual investment decision making because (a) this strategic information is easily recognizable and identifiable and (b) the perception of the participants impacts the final outcome. Yet, takeovers are also influenced by behavioral bias. In this vein, Rosen (2006) posited that investor sentiment is a key factor in the reaction to an announced merger or takeover.

Widespread consensus is found in financial literature that target firms' shareholders were found to have made large gains from takeovers (Firth, 1980). In contrast, some studies have found that the acquiring companies suffered falls in their share prices on the announcement of the TOB (Meeks, 1977; Utton, 1974, among others), while others found either positive gains or zero gains for the shareholders of acquiring companies (Kummer and Hoffmeister, 1978; Langetieg, 1978, among others). This wider range of possible evolutions for the share price of the bidding firms allows us to operationalize the variable ambiguity in each one of the scenarios of our experiment. Yet, for the same informative stimulus, participants face a less ambiguous situation when they have to answer the questions on the target firm shares that when they have to do it on the bidding firm ones.

The 12 scenarios can be classified into four classes depending on the two levels considered for the clarity of the stimulus and the reliability of the source of information (low and high), as shown in

Table 1: (a) scenarios with a clear stimulus and a reliable source (situations 1, 6, and 10), (b) scenarios with a diffuse stimulus and a nonreliable source (situations 2, 5, and 9), (c) scenarios with a diffuse stimulus and a reliable source (situations 3, 8, and 12), and (d) scenarios with a clear stimulus and a nonreliable source (situations 4, 7, and 11).[5]

- INSERT TABLE 1 HERE-

Table 2 shows how the variable clarity of the stimulus was operationalized. We distinguish between news and rumors. Bearing in mind the characterization of rumors given by Allport and Postman (1947), DiFonzo et al. (1994) and Oberlechner and Hocking (2004), we consider them as unclear stimulus in our experiment. Therefore, we only consider clear situations those describing an imminent TOB announcement or reflecting that the bidder has already decided to announce the TOB (See Table 2).

As can be seen in Table 2, the variable reliability of the source was operationalized by considering financial newspapers as more reliable sources than other investors' opinions. We assume, a priori, that comments by the press are more reliable than comments by other investors because published information commonly undergoes a fact-checking process and need to comply with newspapers standards for information quality.

- INSERT TABLE 2 HERE-

Participants were 96 undergraduate students in the degree of Business Administration. The sample size was determined based on the number of students possessing the knowledge required to participate and the available funding for the experiment. Therefore, all the participants are knowledgeable in financial markets and, particularly takeovers, which make up the content of the informative stimulus offered to participants in the decision-making task. The experiment was pretested in a pilot study.

The minimum and maximum payout to a participant was 10€ and 200€, respectively, with an average payment of 17,19€. Participants were rewarded on the basis of the rationality of their decisions. We identify 3 items to penalize individuals' non-rational decisions (a) the individual considers that the share price of the target is going to fall, (b) individual buys (sells) shares when

[5] There are several authors that use experiments to measure the influence of different variables in decision making. For instance, Ghosh and Ray (1997) introduce different levels of ambiguity and risk in decision making.

judging the shares prices are going to fall (rise) (c) in those scenarios with reliable source and clear information, individual believes that the target's shares are going to remain unchanged.

We construct the indexes to measure the behavior of each individual at each step of the cognitive model: noticing, sensemaking and action.

In the first step of our decision-making model, investors notice the stimulus; therefore, we build relevance indexes for both, the target firm (TRI) and the bidder (BRI), to estimate the degree to which participants consider the information as relevant. We construct these indexes as the number of times an individual deems the stimulus to be relevant in the situations corresponding to each type of scenario divided by three, i.e. the number of situations posited in each one of the four types of scenarios. Thus, for example,

$$\text{TRI clear–reliable} = \frac{NTRI}{3}$$

where $NTRI$ is the number of times the participant answers that the share price of the target firm will rise or fall in scenarios with clear stimulus and reliable source.

The second step of our cognitive model is sensemaking. Our focus is to assess if individuals interpret the information noticed in a consistent way with the financial literature. We define a coherent relevance index for each one of the two firms involved in the TOB. The index for the target firm, TCRI is the number of times the participant estimates that the share price for the target firm will rise in the situations corresponding to each type of scenario, divided by the number of times the stimulus is deemed relevant for that firm in those scenarios:

$$\text{TCRI clear–reliable} = \frac{NTCRI}{NTRI}$$

where $NTCRI$ is the number of times a participant believes that the share price of the target firm will rise in scenarios with a clear stimulus and a reliable source of information.

The coherent relevance index for the bidder measures whether the participant believes that the information will have a positive impact on the share price of the bidder (BCRI)[6]. Therefore, BCRI is

[6] The coherent relevance indexes for the bidder when participants believe the information will have a negative impact on the share price (BCRIf) are not defined, since BCRIf=1-BCRI.

the number of times a participant believes that the share price of the bidder will rise in the situations corresponding to each type of scenario, divided by the number of times the stimulus is deemed relevant for that firm in those situations. For example,

$$\text{BCRI clear–reliable} = \frac{NBCRIR}{NBRI}$$

where $NBCRIR$ is the number of times a participant believes that the share price of the bidding firm will rise in scenarios with a clear stimulus and a reliable source of information, and $NBRI$ is the number of times the participant answers that the share price of the bidding firm will rise or fall in scenarios with clear stimulus and reliable source.

Third, we construct activity indexes to measure participants' actions after perception. For each type of scenario, we construct (a) activity indexes for each participant when they estimate that the price will rise (TAIr for the target and BAIr for the bidder), as the number of times the participant negotiates (buy or sell) when they consider the share price will rise divided by the number of times they indicate that perception; (b) activity indexes for each one of the participants when they estimate that the price will fall (TAIf for the target and BAIf for the bidder), as the number of times they negotiate (buy or sell) when they consider the share price will fall divided by the number of times they indicate that perception; and (c) the activity indexes for each one of the participants when they estimate that the price will not be affected (TAIna for the target and BAIna for the bidder), as the number of times they negotiate (buy or sell) when they consider the share price will not be affected divided by the number of times they indicate that perception. Thus, for instance,

$$\text{TAIr clear–reliable} = \frac{NTAIR}{NTR}$$

where $NTAIR$ is the number of times a participant buys or sells the target shares when they declare the share price will rise in scenarios with a clear stimulus and reliable source, and NTR is the number of times a participant indicates the share price of the target will rise in scenarios with a clear stimulus and reliable source.

Finally, we assess the financial coherence depending on how participants perceive the information. We thus calculate the financial coherence index when participants estimate that the price would rise (TFCIr for the target, and BFCIr for the bidder) as the number of times they buy when perceiving a rise in the share price divided by the number of times they indicate that the share price will rise.

Similarly, when participants estimate that the price will fall (TFCIf or BFCIf), we calculate the index as the number of times they sell when perceiving a fall in the share price divided by the number of times they indicate that the share price will fall[7]. For example,

$$\text{TFCIr clear–reliable} = \frac{NTFCIR}{NTR}$$

where $NTFCIR$ is the number of times a participant perceives the target share will rise and buys those shares in scenarios with a clear stimulus and reliable source.

5. Results

Table 3 shows the main descriptive statistics of the cognitive variables, CSI, TOLER (tolerance to ambiguity) and PROAC (proactivity). In average, participants are slightly more analyst than intuitive, more tolerant to ambiguity and more proactive than reactive. In the statistical analyses performed to identify the influence of individuals' cognitive profile on decision making, personality variables were categorized into two levels (lower and higher than the mean value, respectively). The independent samples t-test conducted between the two categories of each one of the three personality variables reflect significant differences in all the cases.

- INSERT TABLE 3 HERE-

The mean and standard deviation of the relevance indexes in the different types of scenarios are shown in Table 4. These results highlight the strong influence of ambiguity on noticing. Table 5 illustrates the descriptive statistics of the financial coherence indexes when subjects consider the stimulus relevant for the share prices. The impact of ambiguity in the sensemaking step is still stronger than in the noticing step. The descriptive statistics of the activity indexes conditioned to perception can be seen in Table 6. Ambiguity influence is softer in action step than in noticing and sensemaking steps. Finally, Table 7 displays the descriptive statistics of financial coherence indexes conditioned to perception.

- INSERT TABLE 4, 5, 6 and 7 HERE-

[7] We have not defined financial coherence indexes when participants perceive that the price will not be affected, since they give the same information as the one given by activity indexes when participants perceive the price will not be affected.

To identify the driving factors in noticing and sensemaking and the main interactions between the context variables and individual traits considered in these two stages, we have carried out repeated measures ANOVA. The significant interactions obtained for the noticing stage can be seen in Table 8 and the ones for sensemaking in Table 9. In sensemaking, financial coherence indexes measure the frequency with which the individual thinks that share prices will rise. The repeated measures ANOVA cannot be done on missing data, hence it only considers the indexes of those individuals for whom the indexes for the two firms exist in the four types of scenarios proposed. Out of 96, 22 individuals judged that the share price of at least one of the two firms will not going to rise in at least one of the 4 types of scenario, thus the analysis was run with 74 individuals. Mean differences obtained for noticing and sensemaking with pairwise comparisons and using Bonferroni adjustment can be seen in Tables 10 and 11, respectively.

- INSERT TABLES 8, 9, 10 and 11 HERE-

In the action stage, the variables that measure the individuals' behavior are the activity indexes and the financial coherence indexes, both conditioned to perception. Of the 96 participants in the experiment, only 23 answered in the four types of scenarios that the share prices of the two companies were going to rise, 5 answered that the share prices were going to fall and 3 that the prices weren't going to change. These groups are too small to implement the repeated measures ANOVA. Therefore, in action stage t-test are performed.

H1 states that ambiguity affects negatively noticing, sensemaking and action. Tables 8 and 9 show that the two levels of ambiguity considered in the experiment are significant for noticing and sensemaking, respectively. Specifically, ambiguity has a negative impact on noticing and sensemaking (Tables 10-Panel A and 11-Panel A, respectively). To test H1 in action stage, we conducted paired-samples t-test comparing action indexes between high and low ambiguity scenarios (Table 12). Without any distinction by the reliability of the source or the information clarity, ambiguity reduces trading only when individuals perceive that the share price is going to rise and reduces financial coherence in both cases, when they perceive that the price will rise or fall. Therefore, our results support Hypothesis 1.

- INSERT TABLE 12 HERE-

H2 states that the individual cognitive profile moderates the influence of ambiguity on the three stages of the decision making process. Table 8 displays that ambiguity has significant interactions for

noticing with proactivity, with the cognitive style and the tolerance to ambiguity, and finally with the three variables of the cognitive profile considered. First, we discuss the interaction of ambiguity with individuals' proactivity. On one hand, ambiguity reduces noticing of individuals characterized by their proactivity. On the other hand, proactivity has a negative impact on noticing in very ambiguous situations.

The interaction of ambiguity and tolerance to ambiguity is also significant in noticing stage depending on individuals' cognitive style. Table 10-Panel A illustrates that ambiguity has a negative impact on noticing for individuals characterized by both, cognitive style and tolerance to ambiguity. Table 10-Panel A also shows that in low ambiguous situations, intuition has a positive impact of noticing for those individuals less tolerant to ambiguity. Finally, in very ambiguous situations, tolerance to ambiguity has a positive impact on intuitive individuals' noticing. Table 10-Panel A also reflects how individuals notice when ambiguity interacts with the three cognitive variables analyzed. Ambiguity has a negative impact on noticing but only for those individuals characterized by their ambiguity tolerance either analysts and proactive or intuitive and less proactive and for those intuitive and proactive individuals but low ambiguity tolerant.

Table 10-Panel A illustrates that in high ambiguity situations, intuition has a negative impact on noticing for those proactive and low ambiguity tolerant individuals. On the other hand, ambiguity tolerance has a positive effect on noticing for proactive and intuitive individuals. Finally, proactivity affects positively noticing of intuitive and less ambiguity tolerant individuals

We have not found empirical evidence of significant interactions between ambiguity and cognitive profile in sensemaking.

To test the influence of context factors and individual traits on action, we perform independent samples t-tests. These analyses identify the differences on activity indexes observed in each type of scenario explained by each one of the cognitive variables. Results displayed in Tables 13 and 14 were significant assuming either equal or unequal variances. Results show the cognitive style has a stronger influence on action in high ambiguity scenarios than in low ambiguity situations. Besides, with high ambiguity, cognitive style has an effect on the trading decision when participants perceive that the share price is going to rise. In contrast, with low ambiguity, the cognitive style affects trading decision when individuals think that the information arrived to the market will not affect the share price. Specifically, Table 13 reflects that in very ambiguous situations, intuition has a negative impact on trading if individuals think the share price is going to rise. Ambiguity tolerance does not explain differences on action indexes. However, Table 14 shows that proactivity produces more

differences on action in high ambiguity situations than in low ambiguity scenarios. Therefore, our results partially support the second hypothesis.

H3 affirms that the interaction among individual cognitive profile, ambiguity and clarity has an impact on noticing and sensemaking. The interaction of ambiguity and information clarity is significant for individual's noticing depending on their ambiguity tolerance and proactivity (Table 8). Ambiguity reduces noticing of proactive individuals characterized by their ambiguity tolerance in scenarios with either clear or unclear information. In contrast, ambiguity only reduces noticing of less proactive individuals if they are either very ambiguity tolerant and receive clear information or they are not ambiguity tolerant and receive unclear information (Table 10-Panel B).

Table 10-Panel B also displays what individuals and in which ambiguity conditions, information clarity has a positive impact on noticing. With low ambiguity, these individuals are either low tolerant and proactive or, on the contrary, high ambiguity tolerant and low proactive. On the other hand, in situations characterized by ambiguity, they are low ambiguity tolerant and low proactive. Ambiguity tolerance improves noticing of those low proactive individuals that receive either unclear information on ambiguous situations or clear information on situations with low ambiguity. Finally, Table 10-Panel B shows the different way proactivity affects low ambiguity tolerant individuals' noticing of clear information depending on ambiguity. Thus, in high ambiguity scenarios, proactivity has a negative impact and in low ambiguity scenarios proactivity has a positive effect.

In Table 9 the interaction of ambiguity and information clarity appears as significant for sensemaking even without considering individuals' cognitive profile. Table 11-Panel B reflects that in the two levels of information clarity considered, ambiguity reduces the frequency of positive interpretation of the stimuli noticed. Besides, only with low ambiguity, information clarity improves investors' positive interpretation of the stimuli.

Ambiguity and clarity also interact with cognitive style and proactivity in sensemaking (Table 9). If we analyze this interaction, we first obtain that for the two levels of cognitive style and proactivity considered, ambiguity reduces the positive interpretation of both, clear and unclear information (Table 11-Panel B). On the other hand, information clarity improves the positive interpretation of low ambiguous stimuli by those intuitive individuals characterized by their proactivity (Table 11-Panel B). Finally, the pairwise comparison reveals that intuition improves positive interpretation of the stimuli when less proactive individuals notice clear information on ambiguous situations. Hence, we find empirical support for H3.

H4 maintains that the reliability of the source of information only has an effect on noticing when it interacts with other context variables and the cognitive profile affects this influence. Our results show that the reliability of the source only has an effect on noticing when it interacts with at least one of the other two context variables considered (Table 8). Below, we only discuss the effect of the interactions of the 3 variables in the context with the 3 variables of the cognitive profile. First, we highlight some of the differences on noticing explained by context variables. Table 10-Panel C1 shows that the more relevant differences are explained by ambiguity, which always has a negative impact on noticing. These differences are mainly observed in low ambiguity tolerant individuals, so if in addition they are intuitive and proactive the differences occur in all scenarios characterized by information clarity and source reliability. Ambiguity also reduces noticing of those ambiguity tolerant, analyst and proactive individuals except in scenarios with unclear information and non-reliable source. In sum, high ambiguity has a negative impact on noticing especially for those individuals with low ambiguity tolerance or high proactivity. The second most important context variable for noticing is clarity of information, having a positive impact on it. This variable affects more analyst individuals than the intuitive, less ambiguity tolerance and less proactive. Therefore, we observe differences on noticing for those analyst individuals, low ambiguity tolerant and low proactive in almost all the scenarios characterized by ambiguity and reliability of the source. (Table 10-Panel C2). Finally, the context variable less relevant for noticing is the reliability of the source of information and in addition it has opposite effects. The reliability of the source only affects those individuals low proactive and low ambiguity tolerant. In scenarios with low ambiguity and clear information, reliability improves noticing of both, analyst and intuitive individuals. In contrast, with high ambiguity and unclear information, reliability improves noticing of the analyst individuals and reduces noticing of the intuitive ones. (Table 10-Panel C2).

Second, we highlight the differences on noticing explained by individuals' cognitive profile. Table 10-Panel C2 shows that the most significant variable for noticing is the cognitive style. It mainly has an impact in ambiguous situations with non-reliable source of information. In these scenarios, analysts notice more stimuli than intuitive individuals if those are low ambiguity tolerant too. In other situations, intuition improves individual's noticing.

The second most significant cognitive variable for noticing is tolerance of ambiguity, having always a positive impact on it, mainly in scenarios with high ambiguity, unclear information and non-reliable source.

Finally, Table 10-Panel C2 shows that proactivity has a negative impact on noticing in ambiguous scenarios with clear information for those intuitive and less ambiguity tolerant individuals. In contrast, proactivity has a positive impact on noticing for analyst and ambiguity intolerant individuals in little ambiguous scenarios where unclear information is given by reliable sources. Our results provide empirical support for H4.

H5 states that individual's cognitive profile interacts with ambiguity, information clarity and reliability of the source to influence investors' action. Table 13 shows that when individuals perceive that the share price is going to rise in very ambiguous situations, intuition has a negative impact on trading. These influences also appear in those scenarios with clear information, with non-reliable source and with both clear information and non-reliable source. On the other hand, in less ambiguous scenarios cognitive style has an impact on action when individuals consider the information will not affect the share price; specifically, when information is clear and when non-reliable sources disseminate clear information in the market, intuitive individuals trade more frequently than analyst ones.

Financial coherence analysis (Table 13) reflects that when ambiguity is high in those scenarios with non-reliable source and with non-reliable source disseminating unclear information, intuition has a negative impact on the decision to sell the shares if these assets are overvalued.

In contrast, when ambiguity is low, intuition has a positive impact on the decision to sell overvalued shares. These significant differences only emerge in those scenarios with clear information and when a reliable source spreads clear information in the market.

Results also reflect a scarce influence of ambiguity tolerance in the action stage of our investor cognitive model. Specifically, this cognitive variable only affects financial coherence. Then, when non-reliable sources disseminate unclear information on low ambiguity situations, ambiguity tolerance has a positive impact on the decision to buy undervalued shares. The mean differences of the financial coherence indexes between the more ambiguity tolerant and less ambiguity tolerant is 0,1646 (sig.= 0,095).

Finally, Table 14 illustrates that proactivity is the cognitive variable with a stronger influence on the action stage and this effect is still clearer in high ambiguity situations. .On one hand, when non-reliable sources disseminate unclear information on very ambiguous situations, proactivity has a positive impact on trading with overvalued shares. On the other hand, if ambiguity is low this effect is only observed when and reliable sources disseminate unclear information.

Table 14 also displays the impact of proactivity on financial coherence.. With high ambiguity, if there is unclear information or the source is non-reliable or these two circumstances, proactivity leads individuals to anticipate to a drop in the share prices. In contrast, with low ambiguity, significant differences only emerge when non-reliable sources disseminate unclear information; in particular, proactivity has a positive impact on the decision of buy undervalued assets.

Hence, our results provide empirical support of Hypothesis 5

Finally, H6 maintains that when the stimulus has not been noticed, proactivity affects positively action. In almost all types of high ambiguity scenarios, high proactive individuals trade more than low proactive individuals when they have not perceived the stimulus. (Table 14). Similarly to more ambiguous situation, proactive individuals trade more than less proactive individuals when they think that the information received is not going to affect the share price in those scenarios that either the source is non-reliable or when unclear information is given by non-reliable sources (Table 14). Hence, our results provide empirical support of Hypothesis 6

6. Conclusions

Our paper develops a decision making model to explain the dynamics of financial markets extending prior research on the financial investment literature. Financial decisions are compelled and constrained by non-financial factors. These include context factors as well as personality characteristics of individuals. Then, our cognitive decision making model includes three stages to investigate the driving factors of investors' decisions and provides empirical evidence on the interaction between environmental factors and individual traits on this process. The context variables are ambiguity, clarity of the informative stimulus and reliability of the source of information, whereas the cognitive profile is defined by cognitive style, ambiguity tolerance and proactivity. The model considerations are tested empirically in an experiment where individuals are provided with information on the possibility of a forthcoming takeover bid. The experiment allows us to observe individual behaviour in the three stages of our model: noticing, sensemaking and action under different context conditions.

Our empirical results indicate a negative influence of ambiguity in the three stages of the decision making process. Besides, we find that cognitive profile moderates this influence in both noticing and action stages. Thus, highly ambiguity tolerant individuals and proactive individuals notice more in high ambiguity contexts whereas intuitive and low ambiguity tolerant individuals notice less in high

ambiguity contexts. In the action phase, analyst individuals trade more frequently than intuitive ones given a high ambiguity context.

When we consider other context variables, the interaction of ambiguity and information clarity with individuals' cognitive profile reveals significant on perception: noticing and sensemaking. In contrast, reliability of the source of information is the least relevant context variable in noticing, as it only has an effect on this stage when it interacts with at least one of the other two context variables.

In contexts characterized by ambiguity, information clarity and reliability of the source, individuals' cognitive style emerges as the most relevant variable for noticing. Thus, intuition improves noticing but when we have a context of high ambiguity with non reliable source of information are analyst individuals who notice more than intuitive ones.

In sensemaking stage, information clarity contributes to interpret low ambiguous stimuli when individuals are proactive. Besides, intuitive individuals give a positive interpretation of the stimuli when information is clear even if the situation is ambiguous.

Finally, proactivity is the most important cognitive characteristic in the action stage. Proactive individuals trade more as the context is less certain. They even trade if the have not perceived the stimuli. Proactive individuals tend to anticipate what they think it is going to happen. Such behavior is clearer as the context is more uncertain. On the other hand, individuals' ambiguity tolerance has not influence on their actions.

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TABLES

Table 1: Scenarios classification
In the decision task of the experiment, individuals faced 12 scenarios classified into four types depending on the two levels of information clarity and the two levels of reliability of the source of information.

	RELIABLE SOURCE	NON-RELIABLE SOURCE
CLEAR STIMULUS	1; 6; 10	4; 7; 11
UNCLEAR STIMULUS	3; 8; 12	2; 5; 9

Table 2: Sources and informative stimulus corresponding to each proposed scenario in the experiment
Notes: R = reliable source. NR = non-reliable source. C = clear stimulus. U = unclear stimulus.

	Source	Stimulus
Scenario 1	Financial newspaper (R)	Formal proposal (C)
Scenario 2	Other financial investors (NR)	Doubts about making or not the TOB (U)
Scenario 3	Financial newspaper (R)	Intention to commence negotiation, searching for support (U)
Scenario 4	Other financial investors (NR)	Intention 50% (C)
Scenario 5	Other financial investors; broker (NR)	Rumor (U)
Scenario 6	Financial newspaper (R)	Imminent TOB announcement (C)
Scenario 7	Other financial investors (NR)	Imminent TOB announcement (C)
Scenario 8	Financial newspaper (R)	Possible interest in TOB (U)
Scenario 9	Financial institution; other investors (NR)	Rumor of a wish for a TOB (U)
Scenario 10	Financial newspaper (R)	Willingness to offer a TOB (C)
Scenario 11	Investors' forum (NR)	Imminent TOB announcement (C)
Scenario 12	Financial newspaper (R)	Possible offer; no decision (U)

Table 3-Cognitive profile variables
Descriptive statistics of personality variables are provided: Cognitive style index (CSI), Ambiguity Tolerance (TOLER), Proactivity (PROAC).

	CSI	TOLER	PROAC
Mean	0,713542	0,6063	0,7644
Median	0,7237	0,60	0,76
Max	0,9474	0,85	0,98
Min	0,2368	0,20	0,46

Table 4-Noticing. Relevance indexes.

Relevance index measures noticing. Mean values (standard deviation) in terms of ambiguity, reliability of source and information clarity are provided.

		Reliable	Non-reliable	Both
High Ambiguity	**Clear**	0,7778 (0,3084)	0,7153 (0,3020)	0,7465 (0,2559)
	Unclear	0,6146 (0,3757)	0,6493 (0,2917)	0,6319 (0,2850)
	Both	0,6962 (0,2912)	0,6823 (0,2443)	0,6892 (0,2308)
Low Ambiguity	**Clear**	0,9097 (0,1709)	0,8090 (0,2593)	0,8594 (0,1716)
	Unclear	0,7639 (0,2775)	0,7778 (0,2848)	0,7708 (0,2166)
	Both	0,8368 (0,1841)	0,7934 (0,2146)	0,8151 (0,1605)

Table 5-Sensemaking. Coherent relevance indexes.

The coherent relevance index measures sensemaking. The mean values (standard deviations) in terms of ambiguity, reliability of source and information clarity are provided.

		Reliable	Non-reliable	Both
High Ambiguity	**Clear**	0,3049 (0,2053)	0,5352 (0,3735)	0,5661 (0,3112)
	Unclear	0,4521 (0,3845)	0,4185 (0,3949)	0,4507 (0,3380)
	Both	0,5596 (0,3230)	0,4813 (0,3032)	0,5204 (0,2679)
Low Ambiguity	**Clear**	0,8333 (0,2757)	0,8116 (0,3147)	0,8252 (0,2499)
	Unclear	0,7429 (0,3136)	0,7509 (0,3303)	0,7460 (0,2430)
	Both	0,7849 (0,2537)	0,7804 (0,2774)	0,7870 (0,2271)

Table 6-Action. Activity Indexes

Activity indexes measure participants' reaction after perception. The activity indexes are calculated when the participants feel the asset price will rise (AIR), when they feel the asset price will fall (AIF), and when they feel the asset price will not change (AINA). Mean values (standard deviations) are provided in terms of ambiguity, source reliability and information clarity.

		Reliable			**Non-reliable**			**Both**		
High Ambiguity	**Clear**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**
		0,7580	0,6469	0,1992	0,7500	0,7103	0,2091	0,7356	0,6866	0,1886
		(0,3727)	(0,4549)	(0,3731)	(0,3922)	(0,4180)	(0,3812)	(0,3482)	(0,4041)	(0,3476)
	Unclear	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**
		0,7099	0,7705	0,1121	0,7222	0,6714	0,0833	0,7155	0,7255	0,1067
		(0,4110)	(0,4004)	(0,2782)	(0,4322)	(0,4423)	(0,2415)	(0,3920)	(0,3823)	(0,2551)
	Both	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**
		0,7535	0,7178	0,1428	0,7298	0,6756	0,1260	0,7443	0,7023	0,1393
		(0,3482)	(0,3879)	(0,3112)	(0,3867)	(0,3887)	(0,2844)	(0,3215)	(0,3442)	(0,2770)
Low Ambiguity	**Clear**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**
		0,8315	0,7031	0,0652	0,8627	0,7241	0,1746	0,8452	0,6833	0,1296
		(0,3088)	(0,4554)	(0,2288)	(0,2831)	(0,4137)	(0,3606)	(0,2794)	(0,4217)	(0,3130)
	Unclear	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**
		0,7405	0,7008	0,1064	0,8012	0,8571	0,2093	0,7744	0,7897	0,1722
		(0,3814)	(0,4381)	(0,2937)	(0,3287)	(0,3542)	(0,3816)	(0,3039)	(0,3842)	(0,3409)
	Both	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**	**Rise**	**Fall**	**No affect**
		0,7899	0,6821	0,0959	0,8283	0,8013	0,2037	0,8115	0,7487	0,1812
		(0,3101)	(0,4311)	(0,2672)	(0,2713)	(0,3735)	(0,3573)	(0,2684)	(0,3750)	(0,3220)

Table 7-Action. Financial Coherence Indexes

The financial coherence index measures the link between perceiving the information and making coherent decisions. It is calculated when participants feel the asset price will rise (FCIR), when they feel the asset price will fall (FCIF). Mean values (standard deviations) are shown for the two levels of ambiguity, reliability of the source and information clarity.

		Reliable		**Non-reliable**		**Both**	
High Ambiguity	**Clear**	**Rise**	**Fall**	**Rise**	**Fall**	**Rise**	**Fall**
		0,5845	0,5650	0,6054	0,6641	0,4183	0,6206
		(0,4349)	(0,4785)	(0,4534)	(0,4385)	(0,3418)	(0,4339)
	Unclear	**Rise**	**Fall**	**Rise**	**Fall**	**Rise**	**Fall**
		0,5432	0,6667	0,5819	0,5095	0,5648	0,5892
		(0,4604)	(0,4544)	(0,4799)	(0,4713)	(0,4506)	(0,4344)
	Both	**Rise**	**Fall**	**Rise**	**Fall**	**Rise**	**Fall**
		0,5819	0,6295	0,5960	0,5726	0,4842	0,5988
		(0,4025)	(0,4305)	(0,4392)	(0,4237)	(0,3488)	(0,3972)
Low Ambiguity	**Clear**	**Rise**	**Fall**	**Rise**	**Fall**	**Rise**	**Fall**
		0,6227	0,5781	0,6176	0,6034	0,6113	0,5722
		(0,4222)	(0,4937)	(0,4468)	(0,4508)	(0,4116)	(0,4428)
	Unclear	**Rise**	**Fall**	**Rise**	**Fall**	**Rise**	**Fall**
		0,5663	0,6439	0,5040	0,7857	0,5389	0,7205
		(0,4587)	(0,4667)	(0,4448)	(0,4153)	(0,4138)	(0,4329)
	Both	**Rise**	**Fall**	**Rise**	**Fall**	**Rise**	**Fall**
		0,5964	0,5864	0,5672	0,7179	0,5815	0,6734
		(0,4127)	(0,4610)	(0,4099)	(0,4169)	(0,3944)	(0,4125)

Table 8-Noticing. Context and cognitive profile interactions.

Relevance indexes measure noticing. Table displays significant interactions obtained from the repeated measures ANOVA with ambiguity, clarity and reliability as intra-subjects factors and CSI, ambiguity tolerance (TOLER) and proactivity (PROAC) as inter-subjects factors. For each interaction F statistic (p value) were shown.

Context variables	**Interaction: context*cognitive profile**	**F (Sig.)**	**Pairwise comparisons key for Table 10**
Ambiguity	Ambiguity	31,864 (,000)	Panel A
	Ambiguity * PROAC	6,770 (,011)	
	Ambiguity * CSI * TOLER	3,428 (,067)	
	Ambiguity * CSI * TOLER * PROAC	6,046 (,016)	
Ambiguity*Clarity	Ambiguity * Clarity * TOLER * PROAC	3,392 (,069)	Panel B
Ambiguity*Reliability	Ambiguity * Reliability * CSI * TOLER	2,853 (,095)	
Clarity*Reliability	Clarity * Reliability	10,144 (,002)	
	Clarity * Reliability * TOLER * PROAC	4,815 (,031)	
Ambituity*Clarity*Reliability	Ambiguity * Clarity * Reliability * TOLER	5,278 (,024)	
	Ambiguity * Clarity * Reliability * CSI * TOLER	4,272 (,042)	
	Ambiguity*Clarity*Reliability*CSI*TOLER*PROAC	3,289 (,073)	Panels C1 and C2

Table 9-Sensemaking. Context and cognitive profile interactions.
The coherent relevance index measures sensemaking. Table displays F statistic (p value) for each significant interaction obtained from the repeated measures ANOVA with ambiguity, clarity and reliability as intra-subjects factors and CSI, ambiguity tolerance (TOLER) and proactivity (PROAC) as inter-subjects factors.

Context variables	Interaction: context * cognitive profile	F (Sig.)	Pairwise comparations key for Table 11
Ambiguity	Ambiguity	79,266 (,000)	Panel A
Ambiguity * Clarity	Ambiguity * Clarity	3,291 (,074)	Panel B
	Ambiguity * Clarity * CSI * PROAC	3,037 (,086)	

Table 10-Noticing. Mean differences. Panel A (Ambiguity), Panel B (Ambiguity*Clarity)
Relevance indexes measure noticing. Table displays mean differences from repeated measures ANOVA and the corresponding p-value obtained from pairwise comparisons with Bonferroni adjustment. Intra-subjects factors are ambiguity, clarity and reliability and inter-subjects factors are CSI, ambiguity tolerance (TOLER) and proactivity (PROAC)

Context	Interaction				Mean difference		Sig.
Panel A							
Ambiguity	Ambiguity				Ambiguity (H-L)	-,133*	,000
	Ambiguity*PROAC			PROAC (H)	"	-,194*	,000
				PROAC (L)	"	-,072*	,030
				Ambiguity (H)	PROAC (H-L)	-,088	,072
	Ambiguity *CSI*TOLER		CSI (H)	TOLER (H)	Ambiguity (H-L)	-,126*	,022
			CSI (H)	TOLER (L)	"	-,069	,076
			CSI (L)	TOLER (H)	"	-,109*	,031
			CSI (L)	TOLER (L)	"	-,227*	,000
			TOLER (L)	Ambiguity (L)	CSI (H-L)	-,089*	,035
			CSI (L)	Ambiguity (H)	TOLER (H-L)	,154*	,027
	Ambiguity *CSI*TOLER* PROAC	CSI (H)	TOLER (H)	PROAC (H)	Ambiguity (H-L)	-,241*	,002
		CSI (H)	TOLER (L)	PROAC (H)	"	-,111*	,036
		CSI (L)	TOLER (H)	PROAC (L)	"	-,144*	,034
		CSI (L)	TOLER (L)	PROAC (H)	"	-,350*	,000
		CSI (L)	TOLER (L)	PROAC (L)	"	-,104	,063
		TOLER (L)	PROAC (H)	Ambiguity (H)	CSI (H-L)	,151	,095
		CSI (L)	PROAC (H)	Ambiguity (H)	TOLER (H-L)	,253*	'017
		CSI (L)	TOLER (L)	Ambiguity (H)	PROAC (H-L)	-,178	,055
Panel B							
Ambiguity* Clarity	Ambituity* Clarity*TOLER *PROAC	TOLER (H)	PROAC (H)	Clarity (H)	Ambiguity (H-L)	-,148*	,029
		TOLER (H)	PROAC (H)	Clarity (L)	"	-,167*	,012
		TOLER (H)	PROAC (L)	Clarity (H)	"	-,109	,102
		TOLER (L)	PROAC (H)	Clarity (H)	"	-,252*	,000
		TOLER (L)	PROAC (H)	Clarity (L)	"	-,209*	,000

		TOLER (L)	PROAC (L)	Clarity (L)	"	-,137*	,007
		TOLER (H)	PROAC (L)	Ambiguity (L)	Clarity (H-L)	,111*	,040
		TOLER (L)	PROAC (H)	Ambiguity (L)	"	,097*	,033
		TOLER (L)	PROAC (L)	Ambiguity (H)	"	,219*	,000
		TOLER (L)	PROAC (L)	Ambiguity (L)	"	,077	,065
		PROAC (L)	Ambiguity (H)	Clarity (L)	TOLER (H-L)	,164	,051
		PROAC (L)	Ambiguity (L)	Clarity (H)	"	,107*	,035
		TOLER (L)	Ambiguity (H)	Clarity (H)	PROAC (H-L)	-,178*	,009
		TOLER (L)	Ambiguity (L)	Clarity (H)	"	,079	,084

Table 10-Noticing. Mean differences. Panel C (Ambiguity*Clarity*Reliability)

Relevance indexes measure noticing. Table displays mean differences from repeated measures ANOVA and the corresponding p-value obtained from pairwise comparisons with Bonferroni adjustment. Intra-subjects factors are ambiguity, clarity and reliability and inter-subjects factors are CSI, ambiguity tolerance (TOLER) and proactivity (PROAC)

Context	Interact						Mean difference		Sig.
Panel C1									
Ambiguity*Clarity*Reliability	Ambiguity*Clarity*Reliability * CSI*TOLER * PROAC	CSI(H)	TOLER (H)	PROAC (H)	Clarity (H)	Reliability (H)	Ambiguity (H-L)	-,222*	,033
		CSI(H)	TOLER (H)	PROAC (H)	Clarity (H)	Reliability (L)	"	-,259*	,030
		CSI(H)	TOLER (H)	PROAC (H)	Clarity (L)	Reliability (H)	"	-,333*	,009
		CSI(H)	TOLER (L)	PROAC (H)	Clarity (H)	Reliability (H)	"	-,167*	,024
		CSI(H)	TOLER (L)	PROAC (H)	Clarity (L)	Reliability (H)	"	-,167	,061
		CSI(H)	TOLER (L)	PROAC (L)	Clarity (L)	Reliability (L)	"	-,178*	,048
		CSI(L)	TOLER (H)	PROAC (L)	Clarity (H)	Reliability (L)	"	-,242*	,025
		CSI(L)	TOLER (L)	PROAC (H)	Clarity (H)	Reliability (H)	"	-,433*	,000
		CSI(L)	TOLER (L)	PROAC (H)	Clarity (H)	Reliability (L)	"	-,333*	,004
		CSI(L)	TOLER (L)	PROAC (H)	Clarity (L)	Reliability (H)	"	-,267*	,026
		CSI(L)	TOLER (L)	PROAC (H)	Clarity (L)	Reliability (L)	"	-,367*	,001
		CSI(L)	TOLER (L)	PROAC (L)	Clarity (L)	Reliability (H)	"	-,292*	,002
		CSI(L)	TOLER (L)	PROAC (L)	Clarity (L)	Reliability (L)	"	-,146	,093

Table 10-Noticing. Mean differences. Panel C (Ambiguity*Clarity*Reliability)
Relevance indexes measure noticing. Table displays mean differences from repeated measures ANOVA and the corresponding p-value obtained from pairwise comparisons with Bonferroni adjustment. Intra-subjects factors are ambiguity, clarity and reliability and inter-subjects factors are CSI, ambiguity tolerance (TOLER) and proactivity (PROAC)

Context	Interact						Mean difference		Sig.
Panel C2									
Ambiguity*Clarity*Reliability	Ambiguity*Clarity*Reliability * CSI*TOLER * PROAC	CSI(H)	TOLER (H)	PROAC (H)	Ambiguity (H)	Reliability (H)	Clarity (H-L)	,222	,062
		CSI(H)	TOLER (H)	PROAC (L)	Ambiguity (H)	Reliability (H)	"	,250*	,048
		CSI(H)	TOLER (H)	PROAC (L)	Ambiguity (L)	Reliability (L)	"	,250*	,036
		CSI(H)	TOLER (L)	PROAC (H)	Ambiguity (L)	Reliability (H)	"	,111	,092
		CSI(H)	TOLER (L)	PROAC (L)	Ambiguity (H)	Reliability (H)	"	,156	,091
		CSI(H)	TOLER (L)	PROAC (L)	Ambiguity (H)	Reliability (L)	"	,200*	,026
		CSI(H)	TOLER (L)	PROAC (L)	Ambiguity (L)	Reliability (H)	"	,289*	,000
		CSI(L)	TOLER (L)	PROAC (H)	Ambiguity (L)	Reliability (H)	"	,200*	,025
		CSI(L)	TOLER (L)	PROAC (L)	Ambiguity (H)	Reliability (H)	"	,396*	,000
		CSI(L)	TOLER (L)	PROAC (L)	Ambiguity (L)	Reliability (H)	"	,146*	,038
		CSI(H)	TOLER (L)	PROAC (L)	Ambiguity (H)	Clarity (L)	Reliability (H-L)	,178*	,046
		CSI(H)	TOLER (L)	PROAC (L)	Ambiguity (L)	Clarity (H)	"	,267*	,000
		CSI(L)	TOLER (L)	PROAC (L)	Ambiguity (H)	Clarity (L)	"	-,229*	,009
		CSI(L)	TOLER (L)	PROAC (L)	Ambiguity (L)	Clarity (H)	"	,146*	,034
		TOLER(H)	PROAC (L)	Ambiguity (H)	Clarity (L)	Reliability (L)	CSI (H-L)	-,223	,090
		TOLER (L)	PROAC (H)	Ambiguity (H)	Clarity (H)	Reliability (L)	"	,207	,086
		TOLER (L)	PROAC (H)	Ambiguity (L)	Clarity (L)	Reliability (L)	"	-,196	,080
		TOLER (L)	PROAC (L)	Ambiguity (H)	Clarity (L)	Reliability (H)	"	,231	,084
		TOLER (L)	PROAC (L)	Ambiguity (H)	Clarity (L)	Reliability (L)	"	-,176	,093
		CSI (H)	PROAC (L)	Ambiguity (H)	Clarity (L)	Reliability (L)	TOLER (H-L)	,281*	,029
		CSI (H)	PROAC (L)	Ambiguity (L)	Clarity (H)	Reliability (L)	"	,231*	,040
		CSI (L)	PROAC (H)	Ambiguity (H)	Clarity (H)	Reliability (H)	"	,356*	,011
		CSI (L)	PROAC (L)	Ambiguity (H)	Clarity (L)	Reliability (H)	"	,390*	,008
		CSI (H)	TOLER (L)	Ambiguity (L)	Clarity (H)	Reliability (L)	PROAC (H-L)	,170	,057
		CSI (L)	TOLER (L)	Ambiguity (H)	Clarity (H)	Reliability (H)	"	-,321*	,009
		CSI (L)	TOLER (L)	Ambiguity (H)	Clarity (H)	Reliability (L)	"	-,279*	,024

Table 11-Sensemaking. Mean differences. Panel A (Ambiguity), Panel B (Ambiguity*Clarity)
The coherent relevance index measures sensemaking. Table displays mean differences from repeated measures ANOVA and the corresponding p-value obtained from pairwise comparisons with Bonferroni adjustment. Intra-subjects factors are ambiguity, clarity and reliability and inter-subjects factors are CSI, ambiguity tolerance (TOLER) and proactivity (PROAC)

Context	Interaction				Mean difference		Sig.
Panel A							
Ambiguity	Ambiguity				Ambiguity (H-L)	-,366*	,000
Panel B							
Ambiguity* Clarity	Ambiguity * Clarity			Clarity (H)	Ambiguity (H-L)	-,409*	,000
				Clarity (L)	"	-,324*	,000
				Ambiguity (L)	Clarity (H-L)	,078*	,006
	Ambiguity * Clarity * CSI * PROAC	CSI (H)	PROAC (H)	Clarity (H)	Ambiguity (H-L)	-,389*	,000
		CSI (H)	PROAC (H)	Clarity (L)	"	-,413*	,000
		CSI (H)	PROAC (L)	Clarity (H)	"	-,469*	,000
		CSI (H)	PROAC (L)	Clarity (L)	"	-,295*	,004
		CSI (L)	PROAC (H)	Clarity (H)	"	-,417*	,000
		CSI (L)	PROAC (H)	Clarity (L)	"	-,260*	,012
		CSI (L)	PROAC (L)	Clarity (H)	"	-,360*	,000
		CSI (L)	PROAC (L)	Clarity (L)	"	-,329*	,000
		CSI (L)	PROAC (H)	Ambiguity (L)	Clarity (H-L)	,118*	,045
		CSI (L)	PROAC (L)	Ambiguity (L)	"	,091	,065
		PROAC (L)	Ambiguity (H)	Clarity (H)	CSI (H-L)	-,189*	,020

Table 12-Action. Paired samples t-test for activity indexes and financial coherence indexes.
Activity indexes measure participants' reaction after perception. The activity indexes are calculated when the participants feel the asset price will rise (AIR), when they feel the asset price will fall (AIF), and when they feel the asset price will not change (AINA). Financial coherence index measures the link between perceiving the information and making coherent decisions. It is calculated when participants feel the asset price will rise (FCIR), when they feel the asset price will fall (FCIF). Scenarios with significant differences are shown. For each pair of scenarios, the mean differences, standard deviation, standard mean error, *t*-statistic, degrees of freedom and level of significance are indicated.

	Mean	Std. dev.	Std. mean error	t	df	Sig.(2-tailed)
BAIr-TAIr	-0,0691	0,2617	0,0284	-2,434	84	0,017
BFCIr-TFCIr	-0,0965	0,2948	0,0320	-3,018	84	0,003
BFCIf-TFCIf	-0,0806	0,3914	0,0475	-1,697	67	0,094

Table 13-Activity Indexes and Financial Coherence Indexes. Differences explained by CSI.

Activity indexes measure participants' reaction after perception. The activity indexes are calculated when the participants feel the asset price will rise (AIR), when they feel the asset price will fall (AIF), and when they feel the asset price will not change (AINA). Financial coherence index measures the link between perceiving the information and making coherent decisions. It is calculated when participants feel the asset price will rise (FCIR), and when they feel the asset price will fall (FCIF). Scenarios with significant differences from independent samples t-tests are shown. For each pair of scenarios, the mean differences, *t*-statistic and level of significance are indicated. CSI is the cognitive style index.

Variable	Context	Mean differences (Analytic-Intuitive)-	t	Sig.
BAIr	All scenarios	0,1448	-2,160	,034
	Clear	0,1594	-2,087	,040
	Non reliable	0,2189	-2,670	,009
	Clear-Non reliable	0,2755	-3,151	,003
BFCIf	Non reliable	0,1628	-1,760	,082
	Unclear-Non reliable	0,1996	-1,800	,076
TAIna	Clear	-0,2090	2,435	,021
	Clear-Non reliable	-0,2394	2,188	,037
TFCIf	Clear	-0,2439	1,834	,074
	Clear-Reliable	-0,3294	1,956	,060

Table 14-Activity Indexes and Financial Coherence Indexes. Differences explained by proactivity

Activity indexes measure participants' reaction after perception. The activity indexes are calculated when the participants feel the asset price will rise (AIR), when they feel the asset price will fall (AIF), and when they feel the asset price will not change (AINA). Financial coherence index measures the link between perceiving the information and making coherent decisions. It is calculated when participants feel the asset price will rise (FCIR), and when they feel the asset price will fall (FCIF). Scenarios with significant differences from independent samples t-tests are shown. For each pair of scenarios, the mean differences, *t*-statistic and level of significance are indicated.

Variable	Context	Mean differences (High-Low Proactivity)	t	Sig.
BAIf	Unclear-Non reliable	0,1814	-1,740	,086
BAIna	All scenarios	0,1365	-2,162	,035
	Clear	0,1896	-2,324	,024
	Unclear	0,1151	-1,893	,064
	Non reliable	0,1484	-2,245	,029
	Clear-Reliable	0,2241	-2,063	,047
	Clear-Non reliable	0,2077	-2,071	,044
	Unclear-Non reliable	0,1166	-1,910	,064
BFCIf	Unclear	0,1929	-1,998	,049
	Non reliable	0,1876	-2,038	,045
	Unclear-Non reliable	0,3532	-3,359	,001
TAIr	Unclear-Reliable	0,1661	-2,113	,038
TAIna	Non reliable	0,1836	-1,977	,054
	Unclear-Non reliable	0,2379	-1,978	,059
TFCIr	Unclear-Non reliable	0,1867	-1,938	,056

Appendix

QUESTIONNAIRE

LABORATORY EXPERIMENT

Participant number ☐

Cognitive Style Index questionnaire. For reasons of confidentiality it cannot be included.

Questionnaire on ambiguity tolerance and proactivity:
For the following statements concerning how you go about your work, score from 1 (totally disagree) to 5 (totally agree). Circle your chosen score:

	Totally disagree-Totally agree				
I enjoy working in situations of high uncertainty	1	2	3	4	5
Uncertainty surrounding my work prevents me from working better	1	2	3	4	5
I get irritated when unexpected events spoil my plans	1	2	3	4	5
I enjoy the challenge of an uncertain situation	1	2	3	4	5
I am always alert to anything which can improve my life	1	2	3	4	5
In any situation I tend to act as a driver to promote constructive change	1	2	3	4	5
It's exciting for me to see how my ideas can change situations	1	2	3	4	5
If I don't like something, I work to try and change it	1	2	3	4	5
I am not concerned with likelihood and odds. When I believe in something I work towards achieving it	1	2	3	4	5
I like my ideas to succeed, even when they clash with contrasting opinions	1	2	3	4	5
I love spotting an opportunity	1	2	3	4	5
I always look for the best way of doing things	1	2	3	4	5
If I have faith in an idea, nothing will stop me from achieving it.	1	2	3	4	5
I see opportunities before others do	1	2	3	4	5