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Lorenzo Esposito, Department of Economic Policy, Università Cattolica del Sacro Cuore, Milano, Italy – Banca d'Italia, Milano, Italy (corresponding author)

✉ lorenzo.esposito@unicatt.it

Letizia Malara, Università Cattolica del Sacro Cuore, Milano, Italy

✉ letizia.malara.lm@gmail.com

Dipartimento di Politica Economica
Università Cattolica del Sacro Cuore – Largo A. Gemelli 1 – 20123 Milano
Tel. 02-7234.2921

✉ dip.politicaeconomica@unicatt.it

https://dipartimenti.unicatt.it/politica_economica

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Abstract

Mainstream theory of finance is based on the assumptions that markets are efficient and economic agents are rational, in the sense that they use optimally the information they have in order to maximize their utility. At least since the "Allais paradox", countless experiments have shown that this is not the case and investors' decisions are often inconsistent. In particular, the researches by Kahneman and Tversky have highlighted that investor behaviors are not rational and sometimes are inconsistent with the logic of the traditional finance theory, due to numerous cognitive biases, which interfere with the choice process of investors. In this paper we investigate some of the most well-known cognitive biases: framing effect, loss aversion, endowment effect, decoy effect and disposition effect. In addition, the availability and representativeness heuristics and their associated biases (confirmation bias, accessibility bias, and conjunction fallacy) are examined. Our experimental methodology is based on a questionnaire consisting of 23 questions and organized into 6 sections, each referring to the various biases examined. The answers obtained differ somewhat from the huge literature on cognitive biases. We understand these differences as mainly connected to the unheard situation created by the Covid-19 pandemic, showing that personal experiences do have an effect on risk preferences.

Keywords: cognitive biases, behavioral economics, prospect theory, pandemic
JEL classification: G41

1. Introduction: the challenge of behavioral economics[*]

Mainstream theory of finance is based on the assumptions that markets are efficient and economic agents are rational, in the sense that they use optimally the information they have in order to maximize their utility function. However, at least since the famous experiment (afterwards called "paradox") proposed by Maurice Allais in 1952 (Egidi, 2017), countless studies have shown that the agent's choices are inconsistent. Although expected utility theory (EUT), together with the efficient market hypothesis (EMH) have remained the dominant explanation of how financial markets work, behavioral economics has gained more and more recognition. More generally psychological insights for economics have received a growing attention, as can be seen from the Nobel prize awarded to Simon, Kahneman, Smith, Thaler and others (for a discussion of the development of behavioral economics see Heukelom, 2014 and Truc, 2022).

In particular, the researches of Kahneman and Tversky have highlighted that investor behaviors are not rational and sometimes are inconsistent with the logic of the traditional finance theory. This detachment from EUT-EMH is not accidental but it is related to numerous cognitive biases, which interfere with the choice process of economic agents, often leading them into errors. In this paper we investigate some of the most well-known cognitive biases: framing effect, loss aversion, endowment effect, decoy effect and disposition effect. In addition, the availability and representativeness heuristics and their associated biases (confirmation bias, accessibility bias, and conjunction fallacy) are examined. The paper first briefly addresses EUT and the alternatives proposed by Kahneman and Tversky, in particular the Prospect Theory (PT). It then describes the experimental methodology used, which is based on a questionnaire consisting of 23 questions and organized into 6 sections, each referring to the various biases examined. The answers obtained are then analyzed, taking into account both the characteristics of the sample and the scientific literature. Finally, we propose some conclusions mainly focused on the differences that emerged from our study compared to traditional findings on the topic.

2. Theoretical issues

To solve empirical anomalies of the finance theory, Kahneman and Tversky, proposed several theories on how individual choose under conditions of uncertainty, bringing to light various cognitive biases and heuristics that impact individual investors every day. In particular, four main points have been put forward:
a) The two systems: Kahneman argues that thinking functions in two main ways that he called system 1 and system 2. System 1 is the primitive and emotional one, typical of quick thoughts, of judgments made impulsively, based on little data, analyzed on the spot. System 2 is the evolved and rational one, typical of slow thoughts, of judgments made cautiously, based on a lot of data, thoroughly analyzed (Kahneman, 2011, ch. 22).
b) The Prospect Theory: in opposition to the standard economic theory, Kahneman and Tversky identified an asymmetrical value function that is concave for gains and convex for losses and is steeper for losses than for gains. This shape is linked to loss aversion (Kahneman and Tversky, 1979).
c) Heuristics: defined as mental and intuitive shortcuts that help give simple answers to difficult questions without employing too much cognitive effort (Tversky and Kahneman, 1974).
d) Cognitive biases: the quick heuristics used to obtain the solution to complex questions can often be misleading and lead to errors called cognitive biases, which take a different form depending on when they occur in the decision-making process (Tversky and Kahneman, 1974). We discuss now these issues in more details.

2.1 The two systems

After many years of research, Tversky and Kahneman showed that all human beings undergo cognitive distortion, that is, brain processes irrationally and unconsciously distort the way we see the world. Rationality, on the other hand, takes over later, when the choice has already been made, to justify it (rationalization). For this reason, Kahneman argues that human thought works in two main ways that he called System 1 and System 2. These are, however, two terms used for explanatory purposes and do not exist in reality: they simply help us shed light on our mental life. System 1 operates quickly and automatically, with little or no effort and no sense of voluntary control. Under its influence, human beings use heuristics, that is, cognitive shortcuts to

[*] The views expressed by Lorenzo Esposito do not involve the responsibility of the Bank of Italy.

draw conclusions from an assumption, efficiently and quickly, but in an unreliable way. Some examples of System 1 are the following:

- Understanding that one object is farther away than another;
- Understanding the origin of a sudden loud sound
- Answering the question: 2+2?;
- Understanding simple sentences;
- Making a disgusted face when looking at a creepy picture.

System 2, on the other hand, is more thoughtful and deliberate: it concentrates attention to demanding mental tasks that require focus, such as complex calculations and its operations are normally associated with the subjective experience of action, choice and concentration. This is the evolved and rational system, typical of slow thinking, judgments made carefully, based on a lot of data, carefully analyzed. In particular, some examples are:

- Focusing on the voice of a particular person in a crowd;
- Counting how many times the letter "a" is found on a page of text;
- Finding a person in a crowd wearing a red scarf;
- Filling out a tax return form;
- Answering the question 43 x 7.

The interaction between the two systems is a recurring theme in cognitive sciences: System 1 continually produces cues for System 2, such as intuitions and impressions that, when corroborated by System 2, are transformed into voluntary beliefs and actions. For example, thanks to System 1 we can instantly intercept fear on a person's face. On the other hand, it is thanks to System 2 that we can slowly solve complex calculations. In this case, each system operates in its own domain of competence: System 1 turns to System 2 when it meets some difficulties, so that the latter solves the problem through detailed and specific processing (as in the case of complex calculus). The division of labor between the two systems is thus very efficient, since it minimizes effort and optimizes performance. Such an organization works well most of the time, mainly due to the fact that System 1 operates correctly, but this is not always the case: System 1 is in fact subject to systematic errors that it makes under specific circumstances and can never be turned off, working even when our attention is focused on something else entirely. Most of our mistakes are the product of System 1's intuitive judgments that have not passed the scrutiny of System 2, and although the latter tries to justify *ex post facto* the rationality of those behaviors, most of them are determined by System 1. Therefore, we need a new view of the economic agent, as well as of human beings in general, aimed at examining not only the rational part, but also the biases that impact each of them and its underlying theories.

2.2 Comparing EUT and PT

EUT is a very old theory. The idea that, when individuals are confronted with different possibilities (as in lotteries and gambles), they will rationally figure out their expected utility from playing and they will maximize the expected result can be considered in fact a *rediscovery*, because it was discussed already by Nicholas Bernoulli (Stigler, 1950). Its more thorough theoretical arrangement has been made by von Neumann and Morgenstern in 1947. EUT is based on the idea that utility maximization, the core of investors' behavior, can be summed up using a deductive procedure based on axioms on rationality. The choices of economic agents are assumed to comply with these assumptions, and from it, many conclusions can be drawn (Colombo, 2021).

The construction of the expected utility function rests on a number of axioms that define the logic underlying investors' decisions (Arrow 1951-1963):

a) Completeness: a rational individual is always able to rank alternatives according to an order of preference;

b) Continuity: a rational individual is always able to indicate the probability that makes him indifferent between an alternative having probability distribution characterized by a better and a worse event and an alternative having certain outcome;

c) Independence of irrelevant alternatives: different outcomes in each alternative will constitute, as a direct consequence, the choice among the different alternatives. However, some elements will be neglected because they are independent of the outcome. From this it follows that the utility derived

from each alternative will be independent of and uncorrelated with the utilities derived from the other choices;

d) Transitivity: given three alternatives, when the first alternative is preferred to the second and, similarly, the second alternative is considered better than the third, if the agent is rational in his choices, then the first alternative will always be preferred also to the third;

e) Non-satiation: for a rational individual, a larger quantity will always be preferred to a smaller quantity. The growth of utility increases along with the growth of probability. Furthermore, given two alternatives with equal gains, the alternative characterized by the higher probability is preferred.

If, for the subject making the choice, all the above axioms are verified, then it is possible to construct a utility function such that, given two choices A and B, choice A is preferred to choice B and the utility function of A and B will register this preference. As for risky situation, we must assume an attitude towards the risk (risk aversion or risk propensity) of the individual based on the aforementioned axioms, and hence his or her form of the indifference curve (convex with risk propensity, linear for risk neutrality, concave for risk aversion). Using this conceptual framework von Neumann and Morgenstern develop an entire theory of individual choices and, in finance theory, Markowitz, Fama and others built the modern mainstream finance economics.

However, the theory suffered many empirical anomalies from the start. A famous example that challenged the theory of expected utility is the already quoted Allais Paradox, which contradicts the axiom of independence (Heukelom, 2014), and that the French economist proposed to Savage, showing that even famous economists do not comply with preferences axioms. Allais proposed the following (slightly modified) experiment:

Choose between alternatives A and B:

A: win 1,000 euro with certainty

B: accept a bet in which there is a 10% probability of winning 5,000 euro, 89% probability of winning 1,000 euro and a 1% probability of winning nothing;

Choose between alternatives C and D:

C: play a bet where there is an 11% chance of winning 1,000 euro and 89% chance of winning nothing

D: play a bet in which there is a 10% chance of winning 5,000 euro and 90% chance of winning nothing.

According to the independence axiom of EUT, a rational individual will prefer A and C. However, almost all respondents answered that they would prefer A in the first choice, but D in the second. It is immediate to show that these results are inconsistent with the axiom. This is just one example of an anomaly which fully contradicts the independence principle of EUT. The same Allais proposed alternatives to the EUT but with no success. Among many of these proposals, the theory that had more success was the PT, modelled along the lines of EUT, but with a purely descriptive intent: its aim is to explain the systematic violations of the axioms of rationality in the choice between risky options.

The first formulation of the PT dates back to 1979, when Kahneman and Tversky published an article presenting their theory on *Econometrica* so to have an audience made by economists not psychologists. It constitutes an alternative model to the EUT in decision-making under conditions of risk, which can rather be seen as a choice between prospects or bets. This theory is based on the idea that individuals evaluate each possible outcome of a decision on the basis of a reference point, or status quo, such as their wealth situation at the time of the decision. In particular, individuals perceive the outcomes of a prospect in terms of gains and losses, rather than as final states of wealth or well-being. It is a descriptive theory and aims to explain why choices deviate systematically from those predicted by standard theory, frequently violating the axioms underlying EUT.

The theory divides the agents' decision-making process into two distinct phases: an initial editing phase and a subsequent evaluation phase.

1. The *editing phase* aims at organizing and reformulating the alternatives available to individuals in order to facilitate the evaluation and final decision phase. It is a preliminary analysis of the prospects and, in turn, can be divided into four sub-phases:

a. *Coding*: the coding of the results takes place at a reference point that usually coincides with the individual's wealth situation at the time of the decision. Given that individuals are interested to variations in terms of gains of losses, the respective coding of 'gains' and 'losses' is influenced by how the prospect is placed and the expectations the agent of it;

b. *Combination*: allows prospects to be simplified by combining the probabilities associated with the same outcome;
c. *Segregation*: is useful for prospects containing both a risk-free component whose outcome is given with certainty and a risky component with an uncertain outcome, thus allowing the two components to be isolated;
d. *Cancellation*: allows the elimination of common elements between the given prospects, considering only the alternatives that it deems most salient.

In addition to these phases, there are so-called additional operations, determined by simplification and detection of dominance. In the first case, it is a matter of rounding the probabilities and value of the outcomes, neglecting those outcomes that are characterized by very low probabilities; the second case, consists of discarding those prospects that are dominated and will not be included in the next evaluation phase.
2. Next comes the *evaluation phase* in which the modified and simplified prospects are evaluated in order to choose the prospect characterized by a higher value. Two functions are used during this phase: the value function and the probability weighting function.

Once the editing stage has been performed and the evaluation has been carried out, the value of the now modified prospect is denoted by V and is expressed in terms of two scales π and v:

π: associates to each probability p a decision weight $\pi(p)$ that expresses the impact of p on the overall value of the prospect;

v: assigns to each outcome x a number v(x) reflecting the subjective value attributed to that outcome. The reference point is the 0 value on the scale; therefore, v measures deviations from the reference point, in terms of gains and losses.

According to this notation, given a prospect (x,p;y,q) the player receives x with probability p, y with probability q and 0 with probability 1-p- q (where $p+q\leq 1$). Three types of prospect can thus be distinguished:

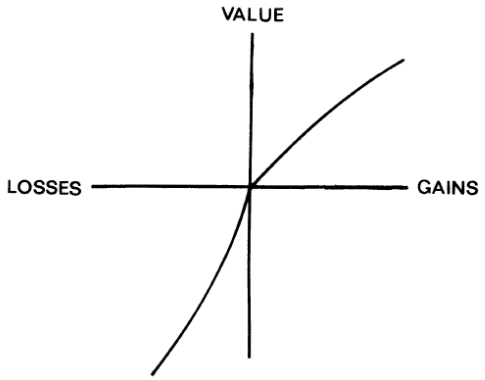
- Strictly positive prospect: the outcomes are all positive ($x,y>0$ and $p+q=1$);
- Strictly negative prospect: the outcomes are all negative ($x,y<0$ and $p+q<1$);
- Regular prospect: it is neither strictly positive nor strictly negative ($x,y<0$ or $x\geq 0\geq y$, or $x\leq 0\leq y$).

Furthermore, in the case of a regular prospect, we have: $V(x,p;y,q)=\pi(p)v(x)$ with $v(0)=0$, $\pi(0)=0$ and $\pi(1)=1$; i.e. the total value of the prospect V is defined on the prospects, while v is defined on the results. On the other hand, the valuation of strictly positive (or negative) prospects, follows a different rule: these prospects are broken down into the risk-free and the risky component. Thus, if $p+q=1$ and $x>y>0$, or $x<y<0$, we have: $V(x,p;y,q)=v(y)+\pi(p)[v(x)-v(y)]$; i.e., the value of a strictly positive (or negative) prospect is the sum of the value of the certain component and the product of the difference in value between the outcomes and the weight associated with the most extreme outcome.

To express the value of the outcomes of a prospect, the value function is used, the main feature of which is that outcomes are not perceived as an end state in absolute terms, but as positive (or negative) changes in wealth relative to a neutral reference point, which is assigned a value of 0. (Kahneman 2011, Kahneman and Tversky, 1979). This reference point constitutes the status quo or the current wealth situation of the individual. It can, however, be influenced by aspirations and expectations and a change in it also modifies the order of preference among prospects. The value function is also characterized by its shape: concave above the reference point, i.e. in the region of gains, and convex below it, i.e. in the region of losses. This implies that the marginal value of gains and losses decreases as their magnitude increases. This is referred to a phenomenon of diminishing sensitivity. It is also important to emphasize what concerns the attitude to change in the state of well-being: losses are perceived to a greater extent than gains, since the pain of losing a sum of money is greater than the pleasure of gaining it. This is found in the value function, which is steeper in the region of losses than in that of gains, thus assuming an asymmetric 'S' shape. This property is called *loss aversion*.

With a value function so defined, it is possible to take into account what is observed in reality: depending on the case, an individual may prefer an alternative with an uncertain outcome rather than a certain one, showing a different attitude to risk each time. In particular, in the section of gains, individuals show risk-averse attitudes in that they prefer a certain gain to an uncertain one, even if of a greater magnitude. In the region of losses, on the other hand, individuals show risk propensity, preferring an uncertain but larger alternative to a certain loss. This loss aversion is followed by the *status quo distortion*: that is, individuals show a strong tendency to keep the status quo because the disadvantages of abandoning it are perceived to be greater than the advantages.

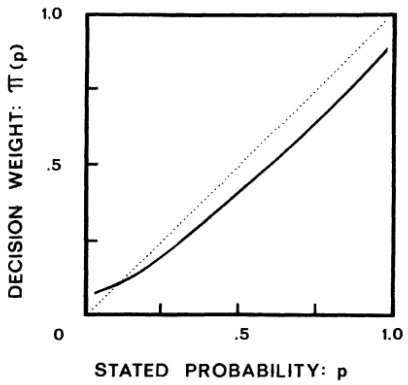
To sum up, the value function satisfies three characteristics: i) deviations from a reference point or adaptation level; ii) principle of decreasing sensitivity (concave function in the gain region and convex in the loss region); iii) loss aversion (steepest slope in the negative domain). Thus it can be represented as follows:



Graph 1 – The form of the value function in Prospect Theory (Kahneman and Tversky, 1979)

In the evaluation phase of the PT, it is also possible to define a weighting function: the value of each outcome is multiplied by a decision weight that measures the impact of an event on the desirability of a prospect, so that the value of an outcome is not a linear function with respect to probabilities. This function is denoted by π and relates the decision weights to the given probabilities. This function π is increasing in p and it holds that $\pi(0)=0$ and $\pi(1)=1$. This implies that outcomes related to an impossible event are neglected and the scale is normalized so that $\pi(p)$ is equal to the ratio of the weight associated with probability p to the weight associated with the certain event. Moreover, for low values of p, the weighting function π is a sub-additive function of p and extremely low probabilities are over-weighted while high probabilities are hypo-weighted. The weighting function is also referred to as *subcertainty*: this implies that preferences are less sensitive to probability variations, as the weight associated with the certain event turns out to be higher than the sum of the weights associated with complementary events.
Finally, we speak of the *subproportionality* property, which states that, given a ratio of probabilities, the one between the corresponding decision weights is closer to 1 when the probabilities are low. This last property, together with the hyper-weighting of low probabilities, implies that the function is sub-additive in the interval and is monotonic and continuous in [0,1].

From the above characteristics, we infer that individuals tend to overreact in the face of events characterized by low probabilities, but react less in the case of events characterized by high probabilities. This implies that low-probability outcomes are over-valued with respect to the certainty of not obtaining them, while highly probable outcomes are under-valued with respect to the certainty of obtaining them. If the weighting function reflects all the characteristics described above, then it can be represented as follows:



Graph 2 – The weighting function in the Prospect Theory (Kahneman and Tversky, 1979)

Although the PT has been developed to solve the anomalies of the EUT, it has its anomalies too. As already pointed out, the assumption of the theory is based on the fact that the reference point, the status quo, has zero

value. This assumption leads to irrational consequences, as can be seen in the following example. The gambler has the following choice:

a) one-in-a-million chance of winning €1 million;
b) 90% chance of winning € 12, 10% chance of winning nothing;
c) 90% chance of winning € 1 million, 10% chance of winning nothing.

According to the PT assumptions, the "win nothing" option unites all three alternatives and thus represents the reference point, whose value is zero. However, this is not true in reality: in alternatives a) and b), the "win nothing" option is not an event, therefore, it makes sense to assign it a value of zero; whereas for alternative c), failing to win represents an extremely disappointing scenario. Therefore, the high probability of winning a large sum establishes a new provisional reference point. Winning nothing, relative to expectations, would be experienced as a big loss. This is what PT is unable to deal with: it does not allow the value of an outcome to change when it is unlikely or when the alternative has a high value, which means that the theory is unable to cope with disappointment. Furthermore, the PT, like the EUT, does not take regret into account: according to both theories, the options available in a choice are valued separately and independently, and generally the choice falls towards the option characterized by a higher value. In this regard, consider the following example:

a) choose between a 90% chance of winning € 1 million and € 50 for sure;
b) choose between 90% chance of winning € 1 million and € 150,000 for sure.

If in both cases the player had to choose the gamble and ends up winning nothing, this outcome would be a disappointment in both cases, but in the second choice the pain would be aggravated by the regret of having chosen a risky choice with a potentially very high outcome, ignoring a certain gain of €150,000. In the face of these two flaws, many economists and psychologists have proposed models of decision-making based on emotions such as disappointment and regret (Loomes and Sugden, 1982). However, the problem is that very often regret theories make few extraordinary predictions compared to those seen in PT, which has also the advantage of being simpler. Despite its flaws, PT has been accepted by many scholars as the best alternative to EUT, adding important theoretical ideas such as the reference point and loss aversion, thus giving a real advantage as predictions that reflect what happens in reality.

2.3 Heuristics

As discussed extensively above, standard decision theory under uncertainty deals with the rationality of preferences and perceptions. Thus, individuals act as if preferences are pre-existing, stable and consistent and as if information is acquired and processed according to probabilities ("as if" formalized in the famous Friedman methodological proposal of 1953). From the rationality of preferences and decisions then follows the rationality of the cognitive process that leads to the maximization of preferences and utility, given market constraints. However, anomalies are often found in investors' behavior, showig how humans often violate the rationality and maximization assumptions underlying standard theory. These economic consequences were studied by Kahneman and Tversky who, in a famous article on *Science* in 1974, introduced the concept of heuristic: when faced with complex problems, individuals resort to heuristics, i.e. intuitive rules of behavior, with which they try to simplify a complex problem. This is an intuitive approach that makes it possible to predict or make a result plausible. On the whole, such heuristics are very useful, but sometimes lead to serious and systematic errors, the so-called 'cognitive bias', as they are the result of mental approximations. In particular, three heuristics play an important role for our aim: availability heuristics, representativeness heuristics and anchoring heuristics.

2.3.1 Availability

The availability heuristic arises when predictions are made regarding the probability of certain events in the future: investors, in order to formulate these probabilities, refer to the examples they can remember that are related to that event and, in gathering this information, are influenced by the ease with which they can recall it. In general, when gathering this information, individuals tend to attribute a higher probability to those events that are more frequent and easier to recall in their minds. The greater the frequency with which an event has occurred in the past, the easier it will be for the individual to believe that it could happen again. Consequently, events that have never occurred will be more difficult to imagine and therefore less likely to occur. However, frequency is not the only thing that influences availability, and the link between frequency and availability is imperfect: this means that it is possible that events experienced in the past may be more available in memory,

even though they are not frequent in reality. For this reason, relying on availability leads to systematic errors due to the retrievability of examples, imaginability and illusory correlation. The bias due to retrievability of examples occurs when individuals judge familiar events to be more numerous than less familiar ones, despite having the same frequency. This is referred to as information accessibility. Besides familiarity, there are other factors, such as salience or relevance, that influence the retrievability of examples. For example, seeing something burning causes an individual to assign more weight to the subjective probability of such a misfortune than reading the news of a fire in a newspaper. Thus, more recent and vivid events will assume greater relevance in the information acquisition process even if they are not necessarily more likely to occur in the future. Furthermore, recent events tend to be relatively more available than events more distant in time. This is referred to as recency bias. Sometimes, however, it is necessary to evaluate the frequency of a series of events whose examples are not retrieved from memory, but are generated according to a given rule. In such situations, individuals tend to produce several examples and assess the frequency or probability of an event according to the ease with which they have constructed them in the mind. However, the ease with which examples are produced does not always reflect their actual frequency, thus generating other biases.

To illustrate this concept, an example can be used (from Tversky and Kahneman, 1974). We want to estimate how many distinct committees of n members can be constructed from a group of 10 persons, according to the formula $2 \leq n \leq 8$. The correct answer to this problem is given by the binomial coefficient which reaches a maximum of 252 for n=5. One way to answer this question without doing calculations is to mentally construct committees of n members and evaluate their number according to the ease with which they come to mind. It is immediate to observe that it is easy to create five disjoint commissions of 2 members, while it is impossible to generate even two disjoint commissions of 8 members. Consequently, if frequency is assessed according to the imaginability or availability of construction, smaller commissions will appear more numerous than larger ones.

This heuristic gives rise also, to another bias, studied by Chapman and Chapman (1967 ad 1969), based on the judgement of the frequency with which two events occur simultaneously. This effect is called illusory correlation and shows itself whenever an investor relies on the associative strength of the link between two events that occur concurrently. If this association is strong, the investor is likely to conclude that the events are concomitant.

2.3.2 Representativeness

Individuals in general correctly utilize the *a priori* probability when they have no other information about an event; on the other hand, this probability is completely ignored as soon as a description is introduced, even if it is not informative at all. To test this hypothesis, a brief example can be used (from Kahneman and Tversky, 1973). Respondents were divided into two groups: each of them was shown brief descriptions of the personalities of several individuals who were said to have been chosen at random from a group of 100, consisting of engineers and lawyers. Both groups were then asked to rate the probability that the person described was either an engineer or a lawyer. In addition, the first set of individuals was told that the group described consisted of 70 engineers and 30 lawyers; the other group was told that there were 30 engineers and 70 lawyers. If we answered this question according to Bayes' Law, the ratio between these probabilities should be $(0.7/0.3)^2$, i.e. 5.44 for each description. However, without the use of calculations, the subjects in the two groups produced the same probability judgements, in clear violation of the law described above. This means that individuals rated the probability of a given profile describing an engineer or a lawyer according to the degree to which the profile itself was representative of the two stereotypes, without considering the *a priori* probabilities of the respective categories.

This shows how individuals tend to use *a priori* probabilities properly when they are not given any scientific evidence; whereas when they are given evidence, albeit worthless, *a priori* probabilities are ignored altogether. Similar to the aforementioned problem is the illusion of validity, according to which a good correspondence between a predicted outcome and the information input provided to a subject generates an unjustified certainty, leading to completely erroneous predictions. In particular, individuals make a prediction on the basis of an outcome that is highly representative of the input provided to them (e.g. inferring a person's occupation on the basis of a description of that person) while factors limiting predictive accuracy are hardly taken into account. Thus, the redundancy of information data reduces accuracy as it increases confidence and people are often confident in predictions that are most likely wrong. Moreover, the excess of information inputs often leads

individuals to consider the probability of a conjunction of events more probable than only one of the two constituent events; this phenomenon is called the conjunction fallacy (Tversky and Kahneman, 1983). It is a fallacy in that, given two events, the conjunction of the same cannot be considered more probable than the two that are part of it, as the conjunction itself would only be a subset of the two; therefore, its probability of occurrence must necessarily be lower than the individual events that make it up.

The description of an event or subject also intervenes in terms of numerical predictions. In particular, when the description is strongly positive or negative, individuals tend to be insensitive to the reliability of the evidence and provide inaccurate numerical predictions. This way of judging violates normative statistical theory which assumes the same prediction for all cases in which the predictability of an event is zero. In reality, however, people show little interest in the predictability considerations underlying statistical theory, basing the reliability of their predictions solely on the positivity or negativity of the description given to them.

When using representativeness heuristics, another common mistake made by individuals is to assess the probability of the outcome of a sampling (e.g. that the average height of a random sample of ten men is 1.80m) on the basis of its similarity to the corresponding parameter (i.e. the average height of the male population), ignoring the size of the sample drawn from a given population altogether. To try to explain this phenomenon, we consider the following test (from Kahneman, 2011):

"*A given city is served by two hospitals. In the larger one 45 babies are born per day, in the smaller one 15. As you know, about 50% of the babies that are born are boys, but the exact percentage varies from day to day: sometimes it is higher, sometimes it is lower than 50%. For one year each hospital records the days on which more than 60% of the babies are boys. Which hospital do you think recorded more such days?*"

Most of the subjects who were asked the question judged that this probability was equal in both the large and the small hospital, thus equally representative of the general population. If, on the other hand, they had relied on the sampling theory, then this probability would have been judged to be higher in the smaller hospital as it is less likely that there was a 50% deviation from the sample in the larger one. A similar insensitivity to sample size was also observed when judging the *a posteriori* probability, i.e. the probability that a sample was drawn from one population rather than another. Here again, it is useful to use an example to explain the concept (from Kahneman, 2011).

"*Imagine a jar full of red and white balls, 2/3 of which are of one colour, 1/3 of another. The first individual pulled five balls out of the jar and discovered that four were red and one was white. Another pulled out twenty balls and discovered that twelve were red and eight were white. Which of the two individuals would be more certain that the jar contained 2/3 red balls and 1/3 white balls, rather than vice versa? What probability judgement should each of them make?*"

In this problem, although it is possible to accurately determine what the *ex post* probabilities are, and assuming there are equal *a priori* probabilities, most individuals believe that the jar contains predominantly red balls, since the percentage of red balls drawn is higher. Thus, there is again a dominance by the percentage of the sample at the expense of the influence of its size, which instead plays a crucial role in determining the true *a posteriori* probability.

The use of this heuristic is also often referred to as a misconception of chance: i.e. individuals expect the essential features of a process (e.g. the repeated tossing of a coin) to be represented globally in the entire sequence and locally in each of its parts. However, a locally representative sequence deviates systematically from the expected frequency, as it contains too many alternations and too few repetitions. This is referred to as the gambler fallacy, in which individuals tend to judge sequences of equiprobable events to be much more (or less) representative than they actually are. Consider, for example, the game of roulette in which, after a long sequence of all reds, the gambler tends to bet on the black, as he/she mistakenly believes that the next black would produce a more representative sequence than another red. According to this view, one thinks of a self-correcting process of the random pattern in which the deviation in a particular direction induces one in the opposite direction that restores equilibrium. However, this is not what happens in reality as the deviations are simply diluted as the random process unfolds.

The misconception of chance manifests itself more generally in what is called the law of small numbers, according to which even small samples are highly representative of the population from which they are drawn (Tversky and Kahneman, 1971). This, however, generates an overestimation of the replicability of a result, leading to the selection of inadequate sample sizes and the attribution of excessive weight to them. Finally, predictions based on representativeness heuristics produce misconceptions of regression. In general, there is a phenomenon called *mean regression*, according to which, given two variables x and y that follow the same distribution, if the mean score of x deviates from the mean of x by k units, then the mean score of y will deviate from the mean of y by less than k units (a discussion is already in Galton, 1886). People, however, do not develop correct intuitions about this phenomenon because they do not expect regression to occur in many contexts in which it inevitably occurs and, even when they recognize it, they assert random explanations to justify it.

The failure to recognize and understand this effect leads to dangerous consequences, such as overestimating the effectiveness of a punishment and underestimating the effectiveness of a reward. In fact, rewards are generally given when one behaves well and punishments when one behaves badly: this happens because of the effect of regression towards the mean, whereby behavior tends to improve after a punishment and worsen after a reward. Rewards and punishments are therefore only apparent consequences of a stronger underlying consequence: mean regression.

2.3.3 Anchoring

Anchoring represents the behavior of economic agents relating to a particularly significant piece of information or a strong initial hypothesis, acting as an anchor (Tversky and Kahneman, 1974). It constitutes the starting point from which to make all subsequent evaluations, which will be over- and under-adjustments to the anchor itself, often resulting in insufficient and therefore erroneous results. In other words, different starting points give different estimates, each with a bias towards the initial value, and this phenomenon is called *anchoring*. This phenomenon shows itself mainly in two ways: through insufficient anchoring adjustments and in the evaluation of conjunctive and disjunctive events. The first case is the most common and simple one, in which, for those events about which there is no certainty, individuals are given a starting point, sometimes even unrelated to the event itself, from which they will make the relevant adjustments to reach the final answer. To show this effect, an experiment was used in which subjects were asked to estimate the number, in percentage, of African countries in the United Nations. The estimated sample was divided into two groups, each of which was given a different starting point before being allowed to make their own assessment. Based on this starting point, the subjects were first asked to indicate whether the number assigned to them was higher or lower than the required quantity, and then asked to estimate the value of this quantity, adjusting the given number up or down. Accordingly, those who were given a rather low number (e.g. 10), adjusted their estimate upwards, conversely did those who were given a rather high number (e.g. 65). In this case, adjustments were made from the given starting point. However, this situation can also occur if the individual bases his estimate on the result of a complete calculation. In fact, without the aid of some device, the estimation of the following calculation (descending sequence)

$$8\times7\times6\times5\times4\times3\times2\times1$$

is necessarily different from the estimate of the same calculation, but with an ascending sequence

$$1\times2\times3\times4\times5\times6\times7\times8$$

This is because two or three calculations are usually performed and the final product is estimated by extrapolation or adjustment in order to answer such questions quickly, and this should lead to an underestimation, as the relevant adjustments are usually insufficient. Furthermore, since the result of the first multiplication operations is higher in the first sequence than in the second, the product of the first expression will be judged to be higher than the product of the second. This heuristic also generates a bias in the evaluation of conjunctive and disjunctive events. This effect was studied by Bar-Hillel who proposed in an experiment to bet on an element of a pair of events (Bar-Hillel, 1973). The events were of three types, as follows:

a) Simple events: drawing a red ball from a bag containing 50% red and 50% white balls;
b) Conjunctive events: drawing a red ball seven times in a row (putting back the ball each time) from a bag containing 90% red and 10% white balls;
c) Disjunctive events: drawing a red ball at least once in seven consecutive attempts (putting back the ball) from a bag containing 10% red and 90% white balls.

Based on the study's findings, most individuals preferred to bet on the subjunctive event whose probability was 48%, rather than the simple event with a higher probability of 50%. The latter was preferred over the

disjunctive event whose probability was 52%. In both comparisons, individuals bet on the least probable event and this leads to a general finding: people tend to overestimate the probability of conjunctive events and underestimate the probability of disjunctive events.

The probability resulting from the simple event (i.e. success at a given stage of the draw) is the starting point for estimating the probabilities of conjunctive and disjunctive events, but since the adjustment from this point is insufficient, the final estimates remain too close to the probabilities of the simple events. Consequently, the anchoring that occurs in these situations generates an overestimation of the probability for conjunctive events and an underestimation for disjunctive events.

2.4 Cognitive biases

As we have already seen, heuristics are useful, but sometimes they do not take some factors into account, thus generating cognitive distortions. They are defined as errors in judgement that our mind can make and their identification is a topic that is still evolving today. Knowing about them is crucial as it helps us to prevent or at least to mitigate their effects.
In the following section we will give only a few descriptions of the many cognitive biases (in addition to those already described in the previous sections) which will subsequently be the subject of our experimental study.

2.4.1 Framing

The framing effect occurs when individuals assess, judge or interpret information according to the context in which it is provided and the manner in which it is presented to them (Tversky and Kahneman, 1981). In this way, the same information may be more or less interesting depending on the characteristics highlighted and thus lead individuals to draw conclusions not based on a rational choice process. Framing can thus be defined as a reference point chosen and highlighted to interfere with the expectations of the recipient of the message and condition its decisions. This effect can be distinguished into three types: positive or negative framing, framing of an attribute and framing in the decision-making process of a risky choice (Roguska, 2021). In the first case, the framing can be positive or negative depending on whether potential advantages or disadvantages are highlighted in the description of an event respectively. Consider, for example, the purchase of a product: a positive framing highlights the advantages of using it, while a negative one highlights negative consequences associated with the decision to not purchasing it. Secondly, the framing of an attribute occurs when framing allows details that would go unnoticed to be highlighted as key elements of a description, thus leading to a focus on that single, albeit irrelevant detail (think for instance of a product feature).

Finally, the framing effect is also found in decision-making under conditions of risk. The desirability of different options depends on how they are perceived by individuals in terms of gains or losses. This effect is generally defined together with loss aversion as an individual's choice falls on the possibility of avoiding potential losses against potential gains. This is a direct consequence of the PT, which shows the asymmetry in the perception of gains and losses. According to various studies it has also been noted that this effect has a greater effect on the elderly population, while having little hold on the young: this stems from the fact that there is a decline in cognitive faculties with increasing age (Tversky and Kahneman, 1985). Overall, important choices are controlled by irrelevant characteristics. This contradicts the assumptions underlying EUT according to which the formulation of a choice does not affect the determination of preferences regarding important topics. Instead, it shows the importance of grasping the extent to which factors defined as irrelevant can become determinants of choices decision.

2.4.2 Loss aversion

Loss aversion explains why individuals feel the pain of a loss more strongly than the pleasure of a gain and results in a tendency to avoid losses rather than risking for a gain. This effect occurs because the human brain is based on a mechanism that tends to concentrate on bad news, showing the dominance of negativity in multiple contexts: loss aversion is one of its outcome. In particular, this aversion is defined by Kahneman as a 'conservative force' that fosters a tendency not to move away from a reference point or status quo, making individuals resistant to change. Thus, when thinking about change, individuals focus more on what they might lose than on what they might gain. In general, therefore, loss aversion favours stability and disfavours change. This concept is defined in detail by the value function of PT, which is concave in the region of gains and

convex in the region of losses and much steeper in the region of losses than in the region of gains, and shows people's reluctance to participate in bets that are equally likely to result in gains or losses. This bias occurs as a consequence of three factors acting concurrently: cognitive structure, socio-economic factors and cultural background (Hendricks, 2018). At the cognitive level, three regions are activated when loss aversion occurs: i) the amygdala which processes fear; ii) the striatum which handles forecast errors and thus influences when loss is to be avoided in the future; iii) the insula lobe that reacts to disgust and, in the field of interest, is activated when we suffer a loss. Socio-economic factors are also involved; among them, wealth plays a key role, affecting the behavior of individuals in accepting a loss more or less easily. Finally, according to many studies (for instance, Wang et al., 2017), cultural values also influence the individual's perception of losses versus gains. In particular, a greater aversion to loss was found in those cultures characterized by individualism because, upon experiencing a loss, an individual would not have the support of his or her community and would be reluctant to accept risks for fear of having to bear the consequences alone. This bias is also inevitably linked to two other effects that will be analyzed below, namely the endowment effect and the disposition effect, and they explicitly show the resistance of individuals to deprive themselves of something they already possess (i.e. the point of reference) for fear of incurring its loss. In conclusion, although loss aversion is important in many survival situations, at the same time it prevents people from making rational choices because they are dominated by a high fear of loss.

2.4.3 Endowment effect

The endowment effect represents the reluctance of individuals to part with assets assigning a higher value to what one already owns than to what one does not own (Thaler, Kahneman and Knetsch, 1991). This means that individuals value and devalue an asset on the basis of its ownership and this influences financial decisions too. This effect arises from our inability to consider the opportunity cost of the good, i.e. the money one gives up by not selling it, in the same way as the out-of-pocket costs one has to incur to buy an asset one does not own. This effect can also be explained by the PT that suggests that the willingness to buy or sell an asset depends on an individual's reference point, which in this case is the ownership of the asset. If the individual owns the good, giving it up would involve pain; if he does not own it, he would consider the pleasure of obtaining it. However, these values are unequal due to loss aversion since giving up a good would cause greater pain than the pleasure of obtaining it. In essence, the effect in question takes the form of a difference between the willingness to pay and the willingness to sell that leads to a reduction in the number of trades that can be realized in a market that, by definition, require a greater willingness to pay than the willingness to sell.

2.4.4 Decoy effect

The decoy effect, also referred to as the *asymmetric dominance effect*, arises when, in the choice between two options, the introduction of a third option produces an asymmetry in the offer that changes the preferences of individuals. Such an option is called 'decoy' or 'asymmetrically dominated option', i.e. it is inferior in all respects to a specific option, but compared to the other, it is inferior only in some aspects and superior in others. When the decoy is included in the offer, a higher proportion of subjects tend to prefer the dominating option when the asymmetrically dominated option is not present. This effect is typically used to influence people's final purchasing behavior because the seller, using the decoy, can push the client to opt for the higher-priced good that now appears to be the more advantageous choice. In this way, the introduction of a third option pushes individuals to make a choice that they would not have made in the presence of only two options. A famous example to explain this effect is that of popcorn at the cinema (Ariely, 2008). Consider the following two options: i) a large pack for € 7; ii) a small pack for € 3. In this case, for the individual it is difficult to choose between the size and the price and could go for the cheaper one. Consider now the introduction of a third option: iii) a medium pack for € 6.50. The inclusion of this option makes most individuals choose the higher-priced product because, for a small price difference, they could get more popcorn. For this effect to work, however, it is necessary that the price of the option in the middle (the decoy) differs only marginally from the option with the highest price and that this difference is negligible compared to that between it and the option with the lowest price. This effect therefore leads individuals to choose the more expensive option even if they do not feel the need to do so because they are misled by comparing the three options. This leads individuals to consider the third option to be more reasonable and satisfactory, succumbing to the deception.

2.4.5 Confirmation bias

Confirmation bias is generally defined as an attitude typical of human nature that leads individuals to confirm their beliefs by means of favourable evidence, rather than searching for contrary evidence that may disprove it. This is a true cognitive bias that leads to a distortion of information and decision-making processes. There are several causes that generate this type of bias: one of them is the defense of personal identity that stems from our opinion and induces us to largely remember only what is consistent with our preconceptions (Peters, 2020). In this bias, contrary to the rules of science, people look for data that is compatible with their beliefs of the moment, leading them to accept hypotheses uncritically and exaggerate the probability of extreme and improbable events occurring. However, if we think to the role played by Kuhn's scientific paradigms, even in science the confirmation bias plays a big role.

2.4.6 Disposition effect

The disposition effect takes the form of the tendency to sell gaining assets prematurely and instead hold losing securities for too long. The underlying concept is once again connected to the PT and, in particular, to loss aversion, which translates into a reluctance to realize losses despite the fact that a loss can be the best choice among the outcomes at stake. The disposition effect also refers to the concept of mental accounting, which distorts the overall view of an investment by making us only consider individual expenses, thus generating irrational decisions linked to the individual account we are evaluating at that moment. In particular, in the disposition effect, individuals open so-called mental accounts when they buy shares and fail to close them when the shares are losing, postponing the time to sell if the stock is losing.

The ones we presented are among the most relevant biases to affect investors' decision.

3. The questionnaire

3.1 The framework

The test involved the formulation of specific questions designed to deepen different aspects of behavioral economics. The following biases were considered: framing effect, loss aversion, endowment effect, decoy effect, heuristics (confirmation bias, accessibility, conjunction fallacy) and disposition effect.

We have proposed questions already used in other studies, in some cases revised appropriately to find if there are differences. The questions are given in Appendix A. The questionnaire has been created using Google Forms platform (https://www.google.it/intl/it/forms/about/), which allowed the questions (the 23 listed below and other seven for biographical purposes) to be divided into 6 sections. The platform then allowed the user to set the compulsoriness of the answers, the collection of information anonymously, and the progress of filling out the questionnaire.

The bibliographic references of the questionnaire are the following: Questions 1 and 2: Shepard (1990); Question 3: Müller-Lyer (1889); Questions 4, 5, 18, 19, 20 and 21: Kahneman (2011); Question 6: Boyce (2021); Questions 7, 22 and 23: Consob (2022); Questions 8, 9, 10, 11 and 17: Kahneman (2003); Questions 12 and 13: Thaler, Kahneman and Knetsch (1991); Questions 14 and 15: Ariely (2008), Question 16: Wason and Kosviner (1966).

3.2 The results

3.2.1 Framing effect

The framing effect has been studied using 7 questions (answers are summarized in Tables 1-7). Interestingly, answers show that testers do not appear to be affected by the framing effect: the vast majority gave the correct answer, regardless of the context figure or the way the question was presented. In particular, 73.2% of the sample answered "no" to Question 1; similarly, a large part of the sample of respondents (84.6%) answered correctly to question 3, overcoming the visual illusion of a different length as was the case for only 15.4% of the respondents and as it is commonly believed to happen. This change it is difficult to relate to a wider use of

the Kahneman System 2; it is more simply, as it has been recently observed, to connect this more precise perception to historical and cultural aspects (Alter 2013, Conti 2018).

On the contrary, the answer to question 2 (Table 2) shows a role for framing. In fact, while just over half of the respondent sample (53.2%) thought the central shape was a B, that is, they read it as a letter in a context of letters and thus disregarded the ambiguity of the shape, the remainder of the sample (46.8%) grasped the ambiguity highlighted by the question itself by thinking the shape was the number 13, that is, reading it as a number in a context of letters. However, since the p-value of this statistic is between 0.1 and 0.25, the result cannot be considered statistically significant.

Table 1 – Question 1 (Shepard modified experiment)

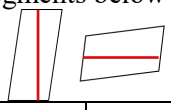
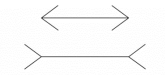
Do the two segments below look oblique? 	
"Yes"	"No"
26.8%	73.2%
p-value < 0.001	

Table 2 – Question 2 (Kahneman and Tversky ambiguity experiment)

What does the central character correspond to? 	
"B"	"13"
53.2%	46.8%
0.1 < p-value < 0.25	

Table 3 – Question 3 (Müller-Lyer illusion experiment)

What do you think is the length ratio between the two segments? 	
"The two segments are equal"	"The two segments have a different length"
84.6%	15.4%
p-value < 0.001	

Questions 4 and 5 assess risk appetite according to the context. In the scenario presented by Question 4, the sample of respondents showed a propensity for risk, having mostly opted for answer B (56.9%): the majority of subjects prefer to accept the gamble in which there is a one-third chance of saving 600 lives, rather than saving 200 lives with certainty. In the answer to Question 5 this propensity is even more pronounced: 68% of subjects accept the situation in which there is a one-third chance that none of the 600 people will die (and thus 600 lives are saved), while 32% prefer the program under which 400 people will die (and thus 200 are saved). Answers A and B proposed for Question 4 are quite equivalent to answers C and D for Question 5. However, the propensity to risk increases from 56.9% of Question 4 to 68% in Question 5. Unlike in Kahneman and Tversky Asian disease experiment, where the respondents showed risk aversion in the scenario of Question 4 and risk propensity in the scenario of Question 5, in our test the sample as a whole does not violate the invariance principle.

According to this principle, two equivalent versions of a choice problem must produce the same preference when shown both simultaneously and separately. In the above experiment, there is a change from risk aversion to risk propensity, whereas in the case examined here there is risk propensity in both scenarios. This difference could be ascribed to the different sample size between the present study (325 respondents) and the above experiment (152 respondents), as well as other differences in the characteristics of the two samples. It is also interesting to note that the answers differ significantly by gender: women are found to be by far risk averse in both cases, while for men the violation of the invariance principle is observed because they show risk aversion in Question 4 and risk propensity in Question 5, as found in the literature.

Table 4 – Question 4 (Kahneman and Tversky Asian disease experiment, I part)

Which vaccination program would you choose to combat an epidemic in a population of 600 people?	
"200 people will be saved"	"600 are saved with a probability of 1/3 and everybody die with a probability of 2/3"
43.1%	56.9%
0.01 < p-value < 0.025	

Table 5 – Question 5 (Kahneman and Tversky Asian disease experiment, II part)

What choice would you make with the following alternatives?	
"400 people will die"	"Nobody dies with 1/3 of probability and everybody dies with 2/3 probability"
32.0%	68.0%
p-value < 0.001	

In the answer to Question 6, there is an unclear situation, whereas the framing effect of two responses provide equivalent information but in two different contexts. In fact, despite the fact that the frame of reference changes radically between the two proposed answers, the respondent sample was divided into two more or less equal parts in the way they answered: slightly more than half (56.3%) chose yogurt containing only 20% fat (negative context) and slightly less than half (43.7%) chose 80% fat-free yogurt (positive context).

On the contrary, answers to Question 7 are clearly affected by the framing effect. In this case, the overwhelming majority of respondents (84.6%) opted for the sanitizer that "kills 95 percent of germs" (positive context), rather than the one that lets only 5 percent survive (negative context). It may be thought that the greater influence of the framing effect stems from a sharper perception between positive and negative context in the case of Question 7 than perceived in the case of Question 6. This difference in perception in relation to contexts that refer to germs may also have been induced by the current pandemic situation.

Table 6 – Question 6 (yogurt experiment)

You are about to enter an ice cream shop with the intention of enjoying a low-fat frozen yogurt. You can choose between the two frozen yogurts presented that show the following information, respectively: "Frozen yogurt Toyo, contains 20% fat" and "Frozen yogurt Dano, 80% fat-free." Which one would you choose?	
"Frozen yogurt Toyo, with 20% fat"	"Frozen yogurt Dano, 80% fat-free"
56.3%	43.7%
0.01 < p-value < 0.025	

Table 7 – Question 7 (sanitizer experiment)

Luke is buying a new sanitizer at the drugstore. He has several options available, but two sanitizers are on discount. One called "Germs-free" and the other called "Germs-out". They have the same price and contain the same amount of product. The only difference is in the labels: in "Germs-free" the label carries the following statement "kills 95 percent of germs"; while in "Germs-out" we find "only 5 percent of germs survive". After comparing the two products, which one would you choose?	
"Germs-free"	"Germs-out"
84.6%	15.4%
p-value < 0.001	

3.2.2 Loss aversion

The expected value of the bet in Question 8 is a gain of € 25. Based on EUT, we could expect that refusing the bet shows risk aversion. The results reported in Table 8 show a substantial parity between those who would accept the bet (49.2%) and those who would refuse it (50.8%). In other words, the respondent sample turns out to be essentially risk neutral and the result is statistically significant. The situation changes slightly if initial wealth is lower (Table 9): in this case fewer people would accept the bet (40.4%) probably because, as wealth decreases, the possible loss is more significant than the expected gain in determining the decision.

Table 8 – Question 8 (Problem 1 in Kahneman and Tversky – part I)

You have a wealth of €1,000. Would you take a bet where, with a 50% chance you can win 150 euros, but you have a 50% chance of losing € 100?	
"Yes"	"No"
49.2%	50.8%
0.75 < p-value < 0.90	

Table 9 – Question 9 (Problem 1 in Kahneman and Tversky –part II)

Would you change your choice if your total wealth was lower than € 100?	
"Yes"	"No"
40.4%	59.6%
p-value < 0.001	

Question 10 compares the choice between a certain loss of € 100 against a bet whose expected value is a loss of € 75. On the basis of the EUT, the respondent sample should favour accepting the bet rather than accepting the certain loss. This is barely reflected in the answers, given that 51.4% would accept the bet while 48.6% would prefer the certain loss (Table 10). This difference is not statistically significant. This choice would remain largely unchanged if the sample had a higher wealth (Table 9: 76.3% would not change their choice). Although in both cases it is confirmed that preference is not determined by a reference point (initial wealth), the attitude towards risk is essentially split in the sample surveyed. In other words, our sample does not show risk aversion in the face of an unappealing bet (Question 8), just as it does not overwhelmingly show risk aversion in the face of a certain loss (Question 10).

Interestingly, when faced with a certain loss (Question 10), people over the age of 50 are by far more risk-averse, preferring to accept the bet (79.6%) rather than a certain loss (20.4%); on the contrary, people of the next generations, i.e., those between 25 and 50 years, are significantly less risk-averse (only 42.9% would accept the bet). Age thus plays a key role in risk choice in the region of losses. In contrast, this characteristic of the sample is less important in the choice of risk in the region of gains, with people over the age of 50 being slightly more risk averse in that region (57.1%) than those in the next generations (51.8%).

Table 10 – Question 10 (Problem 2 in Kahneman and Tversky –part I)

You have a wealth of € 1,000. What would you choose between losing € 100 with certainty and winning € 50 with a 50% probability and losing € 200 with a 50% probability?	
"Certain Loss"	"Bet"
48.6%	51.4%
0.5 < p-value < 0.75	

Table 11 – Question 11 (Problem 2 in Kahneman and Tversky – part II)

Would you change your choice if your total wealth was larger than € 100?	
"Yes"	"No"
23.7%	76.3%
p-value < 0.001	

3.2.3 Endowment effect

In Question 12, a relative majority of respondents (32.6%) assigned to a good to be consumed (in this case, the bottle of wine to be drunk during a dinner party) the current market price (Table 12). To the same good, the current market value is assigned by a significantly higher percentage of respondents (61.8%) if, differently from the previous scenario, the good is to be given away (Question 13) rather than consumed personally (Table 13). We thus observe that in both cases (consuming the good personally or giving it away) people overwhelmingly assign the market value to the good in question, regardless of how much it was paid for initially. However, the fact that almost twice as many respondents assign such a value when the good is given away confirms the endowment effect whereby people tend to assign a higher value when they lose a good they own.

Table 12 – Question 12 (The example of the wine by Thaler – part I)

During a holiday in Tuscany, you bought some bottles of Chianti that you now keep in your cellar. In the meantime, the bottles have greatly gained in value: you had paid € 15 per bottle and now they are worth over € 150. During the holidays, you happen to open one of these bottles with your relatives at home during a dinner party. What monetary value (in euro) do you want to assign to this consumption?				
"0"	"15"	"The today equivalent given the present inflation"	"150"	"135"
20.0%	19.1%	7.7%	32.6%	20.6%
p-value < 0.001				

Table 13 – Question 13 (The example of the wine by Thaler – part II)

Now we just slightly change the scenario: you decide to offer one of these bottles as a gift to a friend, in repayment for a gift from the friend. What assessment do you make of the monetary value (in euro) of your gift?				
"0"	"15"	"The today equivalent given the present inflation"	"150"	"135"
13.8%	12.3%	3.1%	61.8%	9%
p-value < 0.001				

3.2.4 Decoy effect

Question 14 presents three choice options of which one (paper-only subscription) is the so-called decoy in that it makes the option of subscription in paper and digital form at the same price seem significantly cheaper. To this question, 56.3% of the respondents preferred the digital format subscription, 36.3% chose the digital and paper format subscription, and only 7.4% chose the paper-only format subscription (Table 14). Removing the decoy, i.e., the paper-only subscription option that was the least chosen by the sample, one would expect the choice preferences between the remaining two options to remain the same. Instead, Question 15 shows a change in that preference whereby the digital form subscription is still more preferred (64.3%) than when there were three choice options (56.3%), while the choice preference for digital and paper subscription remained almost unchanged (Table 15). In other words, people who had opted for the paper-only subscription choice in Question 14 shifted their preference to the digital-only subscription in the case of Question 15 when only two options were available and the decoy was gone.

This experiment shows that we do not know our preferences too well and that our choices are indeed influenced by cognitive bias. It is also observed that the presence of an option chosen by only a very few significantly changes the choice between the other two options, that is, the so-called axiom of independence from irrelevant alternatives is violated (Arrow 1951-1963). Interestingly, the choice preferences in Question 15 are very similar to those found by Ariely experiment (68% for the digital-only option and 32% for the digital-paper option), while the choice preferences in Question 14 are markedly different (16% for the digital-only option, no choice for the paper-only option, and 84% for the digital-paper option). This difference is probably due to a greater environmental awareness of the sample surveyed, given the importance gained by these issues nowadays, which leads the respondents to prefer the digital-only option to the digital-and-paper option. This aspect assumes even more importance among people under the age of 25, whose preference for the digital-only option is 59.8% while it is less relevant for people over the age of 50, where only 47% chooses this option. The respondent sample's greater familiarity with digital technologies than in the original experiment (digital subscriptions were not as widespread in 2008 as they are now) may also have contributed to the difference found above.

Table 14 – Question 14 (Ariely experiment – part I)

You need to subscribe to a magazine you are interested in. You have three options. Choose the subscription you prefer		
"€ 59 (digital-only)"	"€ 125 (paper-only)"	"€ 125 (paper and digital)"
56.3%	7.4%	36.3%
p-value < 0.001		

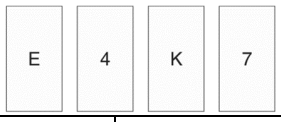
Table 15 – Question 15 (Ariely experiment – part II)

Referring to the previous question, what would be your choice if the options were only the following two?	
"€ 59 (digital)"	"€ 125 (paper and digital)"
64.3%	35.7%
p-value < 0.001	

3.2.5 Confirmation bias

In line with the findings of other researchers, only 2.2% of the respondents gave the correct answer to Question 16 (turning over the card with the letter E and the card with the number 7) although the majority (53.2%) correctly indicated the number of cards to be turned over to answer the question (i.e., two cards) and, of these, 69.4% correctly identified one of the two cards: the card with the letter E (Wason and Kosviner, 1966). Turning over the card with the letter E is correct in that, if by turning over such a card its hidden face shows a 4, then it can be said that the rule has been complied with. However, even if correct, this answer is incomplete. To be really sure that "if there is E on one side of the card, then there is a 4 on the other side" we must also turn over the card with the number 7 to verify that its hidden face does not show the letter "E". Only in this way can we be fully convinced of the correctness of the rule. The fact that only 2.2% of testers gave the correct answer shows that while most people tend to seek the confirmation of a hypothesis (by turning over the E card), their reasoning rarely implements the opposite mechanism, based on discarding possible mistakes (by turning over, in this case, the card with the number 7). This shows the pervasiveness of the confirmation bias.

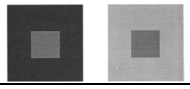
Table 16 – Question 16 (Wason and Kosviner problem of the four cards)

In front of you there are four cards, with a letter on one side and a number on the other. The first and third are turned over on the letter side, the second and fourth on the number side. Indicate the minimum number of cards and which cards must be turned over to prove that the following statement is true "If there is E on one side of the card, then there is a 4 on the other side" (More than one answer can be given). 	
"E, 7"	"number of cards to be turned: 2"
2.2%	53.2%
p-value < 0.001	

3.2.6 Accessibility

In Question 17, the majority of respondents (55.7%) gave a correct answer, showing that their perception is independent from the reference context. There is, however, a fair fraction of the sample (44.3%) whose perception is influenced by the reference. Although the brightness of the two squares enclosed in larger squares is the same, this does not seem to be the case for these people. In fact, for them, the perceived brightness of an area is not only a function of the light reaching the eye from that area, but also depends on the reference value, which is influenced by the context. Indeed, this is a property of perceptual systems that are generally designed to enhance the accessibility of variations and differences between a perceived stimulus and the context of preceding and concurrent stimuli. The fact that perception can be influenced by reference confirms the so-called "Bernoulli error," according to which the decision rule is based on maximizing expected utility and is therefore independent from the reference point. Therefore, we see a certain asymmetry of context dependence whereby there are many more people (41.2%) who consider the square enclosed in the dark background square to be lighter than those who consider the square enclosed in the light background square to be lighter. Moreover, the importance of the age factor in the decision rule is again observed: people aged 25-50 are more prone to context dependence (52.7%) than people over 50 (36.7%).

Table 17 – Question 17 (reference point experiment by Kahneman and Tversky)

Do you think the two smaller boxes in the centre: 		
"Have the same colour"	"the one on the right is lighter than the one on the left"	"the one on the left is lighter than the one on the right"
55.7%	3.1%	41.2%
p-value < 0.001		

3.2.7 Representativeness heuristics and conjunction fallacy

The results of the answers to Questions 18, 19, and 20 are shown in Tables 18, 19, and 20, respectively. Of all the sequences selected to rank possible outcomes in Question 18, only 31.7% of testers indicated a sequence for which outcome B was more likely than outcome C (that is clearly a subset of B). Similarly, in Question 19, 2.2% of respondents indicated "bank teller" as Linda's profession, while 23.1% (i.e., 10 times more than those who opted for teller) indicated "bank teller and activist" for that profession, despite this choice being a subset of the former. What was observed in the previous two questions is also repeated with Question 20, where 84.3% of respondents preferred to bet on the GRGRR sequence, which is necessarily less likely than the RGRR sequence, which was instead chosen by only 9.9% of the respondent sample (the GRGRR sequence was constructed by adding a G to the beginning of the RGRR sequence, so it is obviously less likely than the RGRR sequence). The above results can be characterized as fallacious because they do not follow a logical rule. They constitute clear evidence of a *conjunction fallacy*, which people fall into when they judge that the conjunction of two events is more likely than that of only one of the two events in a direct comparison. It is interesting to note that these results are quantitatively in good agreement with what was found in the original experiments, despite the fact that the characteristics of the samples interviewed were significantly different.

Table 18 – Question 18 (Tennis player problem by Kahneman and Tversky)

Participants were asked to rank four possible outcomes of the upcoming Wimbledon tournament from most to least likely (Björn Borg was the dominant tennis player when the study was conducted). The results are as follows: A: Borg will win the match; B: Borg will lose the first set; C: Borg will lose the first set but win the match; D: Borg will win the first set but lose the match. How would you order them?	
A sequence where B is more likely than C	A sequence with C more likely than B
31.7%	68.3%
p-value < 0.001	

Table 19 – Question 19 (The Linda problem by Kahneman and Tversky)

You have to find out the profession of a woman named Linda, who is in her thirties, single, straightforward and outspoken, highly intelligent, and who when she was a student was deeply interested in social justice issues. Linda's friends, who claim to know her well, however, did not tell you about her current interests and career. You consider eight choices, and among them Linda is:	
"Bank teller"	"Bank teller and feminist"
2.2%	23.1%
p-value < 0.001	

Table 20 – Question 20 (Dices problem by Kahneman and Tversky)

There is a dice with four green sides (G) and two red sides (R). The dice will be rolled about twenty times, and the results of the rolls will be recorded. You are to choose one of the following sequences of throws. If the sequence you chose occurs, you will win € 25. Which sequence do you prefer to bet on?	
"RGRRR"	"GRGRRR"
9.9%	84.3%
p-value < 0.001	

Answering the Question 21 (Table 21), the overwhelming majority of respondents (68.3%) thought that "librarian" was Steve's most likely profession, disregarding the fact that in Italy the number of farmers is many times more than the number of librarians. This is another example of representativeness heuristics, a cognitive process whereby we quickly associate characteristics with categories of people by creating mental representations. Like all heuristics, representativeness is often useful because it saves time, but it runs the risk, being also a cognitive bias, to limit the use of rational thought contributing to our failure in understanding statistics.

Table 21 – Question 21 (The librarian problem by Kahneman and Tversky)

Steve is very shy and withdrawn, always helpful, but with little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail. Is he more likely to be a librarian or a farmer?	
"Librarian"	"Farmer"
68.3%	31.7%
p-value < 0.001	

3.2.8 Disposition effect

As the value of a security held in the financial portfolio increases (Question 22), 56.6% of testers decide to sell all or part of it (Table 22). On the contrary, when the security decreases in value vis à vis the purchase price (Question 23), 62.5% of our sample decides to keep it and only 18.2% would sell it in whole or in part (Table 23). These results confirm the so-called disposition effect, whereby investors tend to keep losing securities in their portfolio to avoid the materialization of a loss, while they prefer to sell winning ones.

Table 22 – Question 22 (behavior with a security whose price goes up)

Imagine that you bought a stock at € 60. In the last month, the price rises to € 120. Lacking any specific information about the stock, how do you act?			
"I buy more"	"I do nothing"	"I sell some"	"I sell it all"
10.8%	32.6%	37.8%	18.8%
p-value < 0.001			

Table 23 – Question 23 (behavior with a security whose price goes down)

Imagine that you bought a stock at € 60. In the last month the price drops to € 30. In the absence of new specific information about the stock, how do you act?			
"I buy more"	"I do nothing"	"I sell some"	"I sell it all"
19.4%	62.5%	11.0%	7.1%
p-value < 0.001			

4. Discussion

In this paper, various aspects of behavioural economics were examined through a questionnaire whose sample was quite diverse in terms of age, gender, occupation, marital status and parenthood. The answers obtained were analyzed both with respect to the sample as a whole and according to their distribution with respect to these characteristics. On the whole, the answers were statistically significant, with the exception of Questions: 2 (ambiguity experiment), 8 (risk appetite) and 10 (loss aversion), which showed a lower degree of significance. These questions describe a situation of high uncertainty for the decision-making process and would have required a larger sample to be able to establish whether the observed preference between the two possible answers was statistically significant. Our results mostly confirmed the role of the effects studied in the decision-making process; however, a deviation from the literature was observed in some cases. Gender and age were the sample characteristics that most differentiated the answers (in particular the gender for Questions 4 and 5 and the age for Questions 10 and 17); whereas educational qualification, parenting and occupation were found to be characteristics that did not significantly influence the response. The results obtained for the effects analyzed are summarized below.

4.1 Framing

The framing effect was examined from different perspectives in view of the vastness of the contexts and the ways in which it can show itself. In particular, the following aspects were examined: perception of illusion and ambiguity, risk propensity and context. The first three questions aimed to investigate the framing effect from the perspective of perception. Overall, the sample was far less sensitive to illusions (Questions 1 and 3), 78.9% having given a correct and context-independent answer. This result differs from what has been stated in various works that report that these illusions instead influence the majority of those surveyed (Goldstein and Brockmole, 2017). It can therefore be assumed that the perception of illusions is determined not only by factors characteristic of the proposed illusion, but also by physiological phenomena and cognitive factors or factors linked to the experience of the people observing. For example, in the perception of Shepard's table illusion (Question 1), also known as the reference frame illusion, where segments may appear differently tilted depending on the tilt of the frame surrounding them, an important factor is the size of the reference frame, whereby the effect increases significantly as the frame is enlarged until it occupies the entire field of vision. Similarly, in Müller-Lyer optical illusion (Question 3) important factors are the angle and length of the arrows whereby decreasing the angle or length of the arrows decreases the effect. However, physiological phenomena such as optical light scattering and lateral interactions also intervene in the perceptual phenomenon as they tend to distort the perception of the length of the horizontal segments.

Furthermore, the perception of the illusion is also determined by the cultural heritage and experiences of the person observing. Returning to the Müller-Lyer illusion, it has been frequently observed in the majority of Europeans and Americans who consider the two segments shown to be of different lengths (Alter, 2013). This perception does not occur in populations of different ethnicities and cultural backgrounds for whom this effect is absent. It may therefore be assumed that the characteristics of the sample interviewed here are different in terms of cultural background and experience from those of the samples examined in other studies. In particular, the low sensitivity to the illusion shown in the two examples discussed above could derive from the sample's experience that, when faced with choice options that might require complex evaluations and calculations, the simplest and most immediate option is often the right one, and so they opt for that. In other words, the more people are exposed to tests on perceptual illusions the less they are prone to them. On the other hand, the ambiguity of the form presented in Question 2 is fully manifested in the sample's response, as it was not known to the respondents. Limited to the sample examined here, it can therefore be assumed that the perceptual phenomenon is much more influenced by ambiguity than by optical illusion. Given that in the investment decisions ambiguity is by far more relevant, this bias remains relevant for supervisory authorities (Linciano, 2010).

Risk propensity and risk aversion were studied with Questions 4 and 5 (the famous Asian disease experiment). The sample showed a slight prevalence of risk aversion in both positive (Question 4) and negative context (Question 5), whereas in the original experiment risk aversion was observed in the positive context and risk aversion in the negative context. The sample size here, which is approximately twice as large as in the original experiment, may have contributed to the discrepancy observed, providing a more representative result.

However, another explanation should be considered. While the problem was only theoretical when originally proposed, in 2022 people has experienced first-hand a painful worldwide pandemic. It is likely that the very high mortality rate observed particularly in Italy at the start of the pandemic and the rapid deployment of the vaccine led those interviewed to prefer the risk of saving as many people as possible in the unconscious hope of mitigating the tragic nature of the event in any way. It can therefore be assumed that the positive or negative perception of a context and thus the aversion or propensity to risk may be influenced not only by the context, but also by the perception of the context itself, which in turn is determined by the situation in which it is presented. In other words, it would seem that the perception of the context is not an absolute concept but relative to the particular situation in being at the time it is presented. Further evidence of the above is provided by the answers to Questions 6 and 7. Both present the same information in a positive context and in a negative context. In Question 6, the different context plays such a marginal role that the sample is virtually split in half between the two answers presented. On the contrary, in Question 7 the role of context is dominant, with the respondent sample much preferring the positive context, identified as a situation in which 95% of germs are killed. The difference between those answers is again the perception of context whereby, in light of the ongoing pandemic, people are most likely to prefer situations that refer to high germ-killing efficacy as they unconsciously associate them with the desire for high efficacy in killing the pandemic virus.

It is interesting to analyse the scientific literature on the subject of risk preference after the explosion of Covid-19 pandemic. The researches have mixed results. Nisani et al. (2022) found that, during the pandemic, investors demonstrated risk-neutral behavior. Angrisani et al. (2020) shown that risk preferences have remained constant, even if normally it is known that "those primed with a bust exhibit higher risk aversion". In Zhang and Palma (2022) this is true on average although with a different gender trend (men are more sensitive to the pandemic and become more risk-averse). On the contrary, Daniel et al. (2020) underlined that the exposure to the Covid-19 reduces individual risk tolerance in the sense that an increase in the infection rate of the area the individual lives in, increases his or her willingness to take risks. Also Tsutsui and Tsutsui-Kimura (2022) found that people became more risk tolerant throughout the period and that were more averse to mega risk than moderate risk due to the individual's perception of the emergency. The different outcomes may depend from the time horizon of the experiments and its timing: the more pandemic develops and has effects, the more it can change risk perception. At any rate, already before the pandemic, many studies have explored risk aversion adaptation to changing circumstances showing that risk preferences are context specific and adaptable (Cuevas Rivera et al., 2018).

The framing effect has a direct reflection on both the investment choices made by investors and on people's willingness to invest. Therefore, it is clear that the decision to invest or not to invest depends on the way the investment is proposed and thus on how the risk is perceived. For example, if an investment opportunity were presented to our sample by referring to potential returns, it is highly likely that they would overwhelmingly opt for that investment. Conversely, if the investment opportunity were presented by reference to potential losses, the risk appetite of the sample studied here would probably be lessened. This effect is often exploited by asset managers and banks selling financial products.

4.2 Loss aversion, endowment effect, and disposition effect

The answers to Questions 8 and 10 do not express a clear loss aversion bias for the sample as a whole, differently from the clear loss aversion reported in the literature, where typically a 2:1 ratio is estimated between the pain associated with a loss and the pleasure derived from an equal amount of gain (Kahneman, 2003). For example, about 70% of a sample of 500 savers interviewed by a group of mathematicians showed loss aversion (Kahneman and Tversky, 1979). In our sample, the same level of aversion is found only in the people over 50 years of age. This shows the importance of age in the choice of risk in the loss region. It is also interesting to note that the average age of savers in Italy is 60, so it can be reasonably assumed that this was the average age in the example above, i.e. very similar to that category in our sample which shows the same level of loss aversion. It was as if people who do not save are less loss averse.

Loss aversion, on the other hand, manifested itself most clearly in the form of the endowment effect, i.e. when comparing the valuation one gives to an asset one owns (Question 12) with the valuation one gives of the same asset in the event of losing it (Question 13). The results show that the number of people who attribute market value to this good (the bottle of wine in Thaler experiment), when it is sold and thus lost, is approximately twice as high as the number of people who attribute the same value when the good is kept or consumed. This fully confirms the statistics reported in the literature for loss aversion, which, in fact, can be considered an alternative interpretation of the endowment effect (Kahneman, 2011, Linciano, 2010). The difference between loss aversion *tout court* and the endowment effect in the sample can be ascribed to the affective value that individuals may assign to a particular object or good.

Similar to the endowment effect, loss aversion also manifested itself prominently in the form of the disposition effect. In fact, the tendency to sell a security that experienced an upturn (Question 22) was approximately three times as high as that observed in the case of a security that experienced a downturn (Question 23). In other words, when a loss has accrued, the sample prefers to postpone the sale in the hope of recouping the loss, thus displaying a clear loss aversion. This behaviour can be explained using PT. If a security held in the portfolio has appreciated, the investor will find himself operating in the earnings area, i.e. the area in which, according to this theory, risk aversion prevails and may therefore decide to sell. Conversely, if a loss has accrued, the investor will find himself operating in the loss aversion area and will therefore be willing to keep the security in his portfolio. In addition, postponing the sale of the loss-making security allows the realization of the accrued loss to be delayed in the hope of recovering it. The difference in behaviour between loss aversion in the case of the depreciating security and classical loss aversion can also be explained by reference to regret aversion,

i.e. the investor is afraid of making a valuation mistake and therefore intends to avoid the regret he/she would feel if the security appreciated after the sale. In summary, owning an asset or a security tends to increase loss aversion as opposed to the case of a loss regardless of emotional value or regret. It will be interesting to analyse whether these results will change in, say, a couple of years of financial markets downturn.

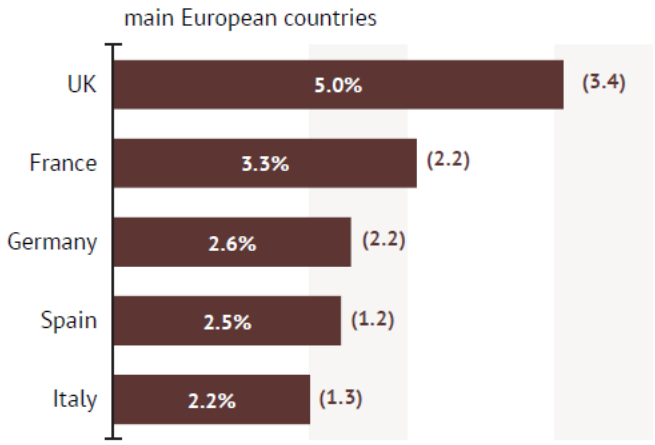
4.3 Decoy effect

The sample confirmed the effect in that the preference expressed in the presence of three options (Question 14), one of which was irrelevant, changes when the decoy is removed (Question 15). Compared to Ariely original experiment, the results differ significantly in the presence of the decoy, while they are substantially the same when it is removed. This difference is accentuated in the answers of people under the age of 25. In fact, it turns out that the digital subscription option is preferred by 56.3% of our sample, which becomes 59.8% when considering people under the age of 25, while the preference for digital only amounts to 47% among the over 50. In the original experiment, the digital-only option in the presence of decoy was chosen by only 16% of the sample. This difference may be due to two factors: i) younger people care more about environmental issues and ii) they have a greater familiarity with digital technologies, which have more commonly used in recent years. Similarly to what has already been discussed for the framing effect, the working of decoy effect seems mediated by the characteristics of the individual in terms of age, experience, etc. This result is of great interest to develop marketing campaigns.

4.4 Heuristics

Broadly speaking, the sample confirmed the presence of cognitive bias due to heuristics such as availability and representativeness heuristics. In particular, the confirmation bias due to the availability heuristic was found in Question 16 whereby the overwhelming majority gave an answer that tended to seek confirmation of a hypothesis (turn over the card with the letter E to see if its hidden face shows a 4) rather than looking for information that might disprove it (turn over the card with the number 7 to see if its hidden face does not show the letter E). In finance, confirmation bias leads investors to accept information, sometimes incorrect or too general, that confirms their financial belief. For example, the general belief that bonds and government securities are low-risk could lead to opt for this type of investment, without taking into account the specific default risk of a country or the possible forex risk (as, for example, it happened with Argentina).

Similarly, the bias related to the accessibility of information induced a large part of the sample to give an answer influenced by the reference, considering the two smaller squares enclosed in larger squares of different background to be of different luminance (Question 17). The result of this experiment gives evidence of how perceptions are reference-dependent. In this specific case, the two smaller squares have the same luminance, but do not appear equally bright as the perception of the brightness of an area is not only a function of the light energy reaching the eye from that area, but also depends on the simultaneous stimulus it receives from the context in which that area is enclosed and therefore reflects the contrast between the two stimuli (phenomenon of simultaneous contrast). This means that our sample would tend to assess as riskier and therefore not invest in products they know little about or about which they have little information and for which they therefore lose their point of reference. This seems to be confirmed by the latest financial bubble, that is crypto-assets, that has scarcely affected Italian investors, given that it was the country with the lower share of population owing crypto-assets among the major European economies (Consob, 2022); this also because these are assets connected to younger generations and the average Italian investor is sixty (see the following graph):



Graph 3 – The share of population owning crypto-assets in Europe (Consob, 2022)

There were also clear confirmations for the representativeness heuristic, in particular with regard to the conjunction fallacy. Four cases were considered in this respect: the tennis player problem (Question 18), Linda's problem (Question 19), the dice problem (Question 20) and the librarian problem (Question 21). In all cases, the sample leaned sharply towards choices that favoured options that were by construction less probable than others, the most preferred option being a subset of the least preferred. For example, in the case of the Linda experiment, only 2.2% of the respondents thought Linda's profession was bank teller, while 23.1% of the respondents (i.e. 10 times more than those who opted for bank teller) thought Linda was a bank teller and activist in feminist movements. These results show a fallacy of conjunction in the majority of the sample surveyed, having judged in a direct comparison the conjunction of two events more likely than only one of them. In the financial sphere, this could translate into investment choices that favour stocks of companies with high profit growth margins in the belief that they are more profitable than other stocks, without taking into account the fact that the stock market can give and has in the past given high returns even with stocks associated with flat or even negative profit growth.

When assessing investors' fallacies, supervisory authorities should consider whether these fallacies are connected somewhat to investors' experience, context, cultural environment and so on. For instance, the campaigns of financial education that are one of the main tool in conduct of business supervision nowadays, would be useless if investors would not benefit from them. The same Kahneman made mixed observations on the issue. For instance, discussing the Linda problem, he noted: "The League of Women Voters is no longer as prominent as it was, and the idea of a feminist "movement" sounds quaint, a testimonial to the change in the status of women over the last thirty years. Even in the Facebook era, however, it is still easy to guess the almost perfect consensus of judgments: Linda is a very good fit for an active feminist, a fairly good fit for someone who works in a bookstore and takes yoga classes—and a very poor fit for a bank teller or an insurance salesperson" (Kahneman, 2011, p. 153). Therefore, he concluded: "As in the Müller-Lyer illusion, the fallacy remains attractive even when you recognize it for what it is" (ivi, p. 155).

To conclude, our study confirmed the importance of behavioural distortions in decision-making in an uncertain environment. Such distortions can lead people, and investors in particular, to irrational behaviour that causes systematic and recurring errors in their decisions. Moreover, the results obtained also highlighted how the age of people and the historical moment in which they live play an important role in the way these distortions work. Further studies and insights to assess the cognitive biases described above in light of the characteristics of the sample surveyed could be very useful for a more detailed understanding and interpretation of investors behavior for the future.

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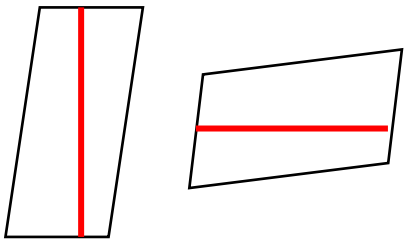
APPENDIX A– The questions

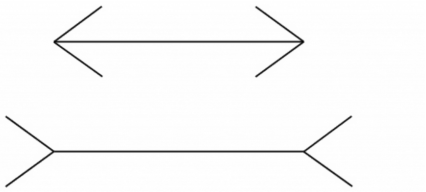
Question 1
Do the two segments below look oblique?



- Yes
- No

Question 2
What does the central character correspond to? B or 13?

Question 3



What do you think is the length ratio between the two segments?

- "The two segments are equal"
- "The two segments have a different length"

Question 4
Which vaccination program would you choose to combat an epidemic of a population of 600 people?

- A: 200 people will be saved
- B: 600 are saved with a probability of 1/3 and everybody die with a probability of 2/3

Question 5
What choice would you make with the following alternatives?

- C: 400 people will die"
- D: Nobody dies with 1/3 of probability and everybody dies with 2/3 probability

Question 6
You are about to enter an ice cream shop with the intention of enjoying a low-fat frozen yogurt. You can choose between the two frozen yogurts presented that show the following information, respectively: "Frozen yogurt Toyo, contains 20% fat" and "Frozen yogurt Dano, 80% fat-free." Which one would you choose?

- Frozen yogurt Toyo, with 20% fat
- Frozen yogurt Dano, 80% fat-free

Question 7
Luke is buying a new sanitizer at the drugstore. He has several options available, but two sanitizers are on discount. One called "Germs-free" and the other called "Germs-out". They have the same price and contain the same amount of product. The only difference is in the labels: in "Germs-free" the label carries the following statement "kills 95 percent of germs"; while in "Germs-out" we find "only 5 percent of germs survive." After comparing the two products, which one would you choose?

- Germs-free
- Germs-out

Question 8
You have a wealth of € 1,000. Would you take a bet where, with a 50% chance you can win € 150, but you have a 50% chance of losing € 100?
- Yes
- No

Question 9
Would you change your choice if your total wealth was lower than € 100?
- Yes
- No

Question 10
You have a wealth of € 1,000. What would you choose between losing € 100 with certainty and winning € 50 with a 50% probability and losing € 200 with a 50% probability?
- Certain Loss
- Bet

Question 11
Would you change your choice if your total wealth was larger than € 100?
- Yes
- No

Question 12
During a holiday in Tuscany, you bought some bottles of Chianti that you now keep in your cellar. In the meantime, the bottles have greatly gained in value: you had paid € 15 per bottle and now they are worth over € 150. During the holidays, you happen to open one of these bottles with your relatives at home during a dinner party. What monetary value (in euro) do you want to assign to this consumption?
- 0, because we already have bottles at home
- 15, as it was paid for it at the time
- The today's equivalent of those € 15, considering inflation
- 150, which is the current market price
- A gain of 135, which is the difference between today's value and the price paid then

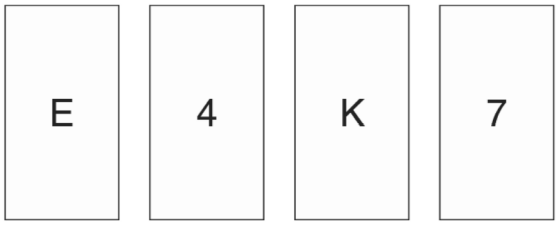
Question 13
Now we just slightly change the scenario: you decide to offer one of these bottles as a gift to a friend that bought you a gift. What assessment do you make of the monetary value (in euro) of your gift?
- 15, as it was paid for it at the time
- The today's equivalent of those euros, considering inflation
- 150, which is the current market price
- A gain of 135, which is the difference between today's value and the price paid then

Question 14
You need to subscribe to a magazine you are interested in. You have three options. Choose the subscription you prefer:
- € 59: Digital only
- € 125: Paper only
- € 125: Digital and paper

Question 15
Referring to the previous question, what would be your choice if the options were only the following two?
- € 59: Digital only
- € 125: Digital and paper

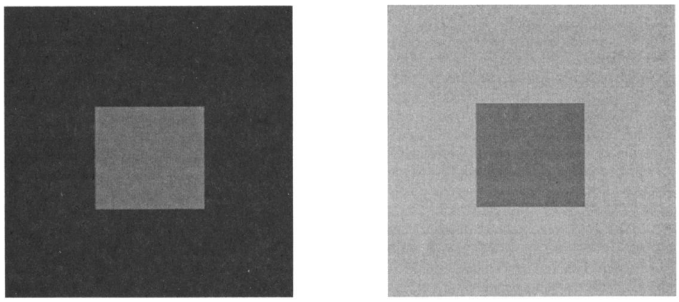
Question 16
In front of you there are four cards, with a letter on one side and a number on the other. The first and third are turned over on the letter side, the second and fourth on the number side. Indicate the minimum number of cards

and which cards must be turned over to prove that the following statement is true "If there is E on one side of the card, then there is a 4 on the other side" (More than one answer can be given).



E; 4; K; 7

Question 17
Looking at the two smaller boxes in the centre, do you think that:



- They have the same colour
- The one on the right is lighter than the one on the left
- The one on the left is lighter than the one on the right

Question 18
Participants were asked to rank four possible outcomes of the upcoming Wimbledon tournament from most to least likely (Björn Borg was the dominant tennis player when the study was conducted). The results are as follows: A: Borg will win the match; B: Borg will lose the first set; C: Borg will lose the first set but win the match; D: Borg will win the first set but lose the match. How you would rank them?

Question 19
Imagine that you have to find out about the profession of a woman named Linda, who is in her thirties, single, straightforward and outspoken, very intelligent, and who when she was a student was deeply interested in social justice issues. Linda's friends, who claim to know her well, however, did not tell you about her current interests and career. Considering the following eight choices:

- Linda is a teacher in elementary school
- Linda works in a bookstore and takes yoga classes
- Linda is active in the feminist movement
- Linda is a psychiatric social worker
- Linda is a member of the League of Women Voters
- Linda is a bank teller
- Linda is an insurance salesperson
- Linda is a bank teller and is active in the feminist movement

Question 20
There is a regular six-sided dice with four green faces and two red faces. It is rolled 20 times. You are shown three sequences of greens (G) and reds (R), and yuu are asked to choose one. You would (hypothetically) win € 25 if the chosen sequence showed up. The sequences were

- RGRRR
- GRGRRR

- GRRRRR

Question 21
Steve is very shy and withdrawn, always helpful, but with little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail. Is he more likely to be a librarian or a farmer?

Question 22
Imagine that you bought a stock for € 60. In the last month, the price rises to 120. In the absence of any new specific information about the title, how do you act?

- buy more
- do nothing
- sell some of it
- sell everything

Question 23
Imagine that you bought a stock for € 60. In the last month, the price drops to 30. In the absence of any new specific information about the title, how do you act?

- buy more
- do nothing
- sell some of it
- sell everything

APPENDIX B – Summary of the answers with all the sample characteristics

Sample composition

Characteristic		%
Gender	Women	59.1%
	Men	40.0%
	Not Specified	0.9%
Age (in years)	< 25	50,5%
	>25 and < 50	34.4%
	> 50	15.1%
Qualification	Degree	64.3%
	High School Degree	28.3%
	Middle school degree	1.5%
	Not Specified	5.9%
With/without kids	Without	81.5%
	With	18.5%
Marital Status	Single	34.5%
	Couple	65.5%
Employment	Students	32.0%
	Employed	64.3%
	Unemployed/Retired/Housewife	4.0%

Table B.1 – Question 1

Characteristic		"Yes" (%)	"No" (%)
Overall		**26.8**	**73.2**
Gender	Women	30.2	69.8
	Men	20.8	79.2
Age (in years)	≤ 25	22.0	78.0
	25 < and ≤ 50	31.2	68.8
	> 50	32.7	67.3
Qualification	High School Degree	28.9	71.1
	Graduate	25.8	74.2
With/without kids	Without	25.7	74.3
	With	31.7	68.3
Marital Status	Single	24.1	75.9
	Couple	28.2	71.8
Employment	Students	22.1	77.9
	Employed	28.0	72.0

Table B.2 - Question 2

Characteristic		"13" (%)	"B" (%)
Overall		**46.8**	**53.2**
Gender	Women	50.5	49.5
	Men	41.5	58.5
Age (in years)	≤ 25	46.3	53.7
	25 < and ≤ 50	45.5	54.5
	> 50	51.0	49.0
Qualification	High School Degree	46.4	53.6
	Graduate	48.3	51.7
With/without kids	Without	44.9	55.1
	With	55.0	45.0
Marital Status	Single	46.4	53.6
	Couple	46.9	53.1
Employment	Students	44.2	55.8
	Employed	46.9	53.1

Table B.3 – Question 3

Characteristic		"The two segments are equal" (%)	"The two segments have a different length" (%)
Overall		**84.6**	**15.4**
Gender	Women	84.4	15.6
	Men	86.2	13.8
Age (in years)	≤ 25	86.6	13.4
	25 < and ≤ 50	84.8	15.2
	> 50	77.6	22.4
Qualification	High School Degree	78.4	21.6
	Graduate	86.6	13.4
With/without kids	Without	86.4	13.6
	With	76.7	23.3
Marital Status	Single	87.5	12.5
	Couple	83.1	16.9
Employment	Students	84.5	15.5
	Employed	83.1	16.9

Table B.4 – Question 4

Characteristic		"200 people will be saved" (%)	"600 are saved with a probability of 1/3 and everybody die with a probability of 2/3" (%)
Overall		**43.1**	**56.9**
Gender	Women	35.4	64.6
	Men	55.4	44.6
Age (in years)	≤ 25	48.8	51.2
	25 < and ≤ 50	35.7	64.3
	> 50	40.8	59.2
Qualification	High School Degree	45.4	54.6
	Graduate	41.6	58.4
With/without kids	Without	44.5	55.5
	With	36.7	63.3
Marital Status	Single	47.3	52.7
	Couple	40.8	59.2
Employment	Students	53.8	46.2
	Employed	38.2	61.8

Table B.5 – Question 5

Characteristic		"400 people will die" (%)	"Nobody dies with 1/3 of probability and everybody dies with 2/3 probability" (%)
Overall		**32.0**	**68.0**
Gender	Women	24.0	76.0
	Men	44.6	55.4
Age (in years)	≤ 25	37.8	62.2
	25 < and ≤ 50	27.7	72.3
	> 50	22.4	77.6
Qualification	High School Degree	37.1	62.9
	Graduate	29.7	70.3
With/without kids	Without	34.3	65.7
	With	21.7	78.3
Marital Status	Single	35.7	64.3
	Couple	30.0	70.0
Employment	Students	38.5	61.5
	Employed	28.0	72.0

Table B.6 – Question 6

Characteristic		"Frozen yogurt Toyo, with 20% fat" (%)	"Frozen yogurt Dano, 80% fat-free" (%)
Overall		**56.3**	**43.7**
Gender	Women	42.2	57.8
	Men	46.2	53.8
Age (in years)	≤ 25	45.7	54.3
	25 < and ≤ 50	43.8	56.2
	> 50	36.7	63.3
Qualification	High School Degree	40.2	59.8
	Graduate	44.0	56.0
With/without kids	Without	45.3	54.7
	With	36.7	63.3
Marital Status	Single	48.2	51.8
	Couple	41.3	58.7
Employment	Students	49.0	51.0
	Employed	41.1	58.9

Table B.7 – Question 7

Characteristic		"Germs-free" (%)	"Germs-out" (%)
Overall		**84.6**	**15.4**
Gender	Women	85.4	14.6
	Men	83.1	16.9
Age (in years)	≤ 25	84.1	15.9
	25 < and ≤ 50	84.8	15.2
	> 50	85.7	14.3
Qualification	High School Degree	84.5	15.5
	Graduate	85.6	14.4
With/without kids	Without	84.2	15.8
	With	86.7	13.3
Marital Status	Single	85.7	14.3
	Couple	84.0	16.0
Employment	Students	85.6	14.4
	Employed	85.0	15.0

Table B.8 – Question 8

Characteristic		"Yes" (%)	"No" (%)
Overall		**49.2**	**50.8**
Gender	Women	44.8	55.2
	Men	45.0	55.0
Age (in years)	≤ 25	51.8	48.2
	25 < and ≤ 50	48.2	51.8
	> 50	42.9	57.1
Qualification	High School Degree	44.3	55.7
	Graduate	50.2	49.8
With/without kids	Without	50.9	49.1
	With	41.7	58.3
Marital Status	Single	57.1	42.9
	Couple	45.1	54.9
Employment	Students	51.9	48.1
	Employed	48.8	51.2

Table B9 – Question 9

Characteristic		"Yes" (%)	"No" (%)
Overall		**40.4**	**59.6**
Gender	Women	38.5	61.5
	Men	43.1	56.9
Age (in years)	≤ 25	43.3	56.7
	25 < and ≤ 50	38.4	61.6
	> 50	34.7	65.3
Qualification	High School Degree	39.2	60.8
	Graduate	39.7	60.3
With/without kids	Without	41.1	58.9
	With	36.7	63.3
Marital Status	Single	40.2	59.8
	Couple	40.4	59.6
Employment	Students	46.2	53.8
	Employed	38.2	61.8

Table B.10 – Question 10

Characteristic		"Certain Loss" (%)	"Bet" (%)
Overall		**48.6**	**51.4**
Gender	Women	52.6	47.4
	Men	41.5	58.5
Age (in years)	≤ 25	51.2	48.8
	25 < and ≤ 50	57.1	42.9
	> 50	20.4	79.6
Qualification	High School Degree	52.6	47.4
	Graduate	45.0	55.0
With/without kids	Without	52.5	47.5
	With	31.7	68.3
Marital Status	Single	53.6	46.4
	Couple	46.0	54.0
Employment	Students	48.1	51.9
	Employed	49.8	50.2

Table B.11 – Question 11

Characteristic		"Yes" (%)	"No" (%)
Overall		**23.7**	**76.3**
Gender	Women	25.0	75.0
	Men	22.3	77.7
Age (in years)	≤ 25	26.2	73.8
	25 < and ≤ 50	21.4	78.6
	> 50	20.4	79.6
Qualification	High School Degree	24.7	75.3
	Graduate	23.0	77.0
With/without kids	Without	24.5	75.5
	With	20.0	80.0
Marital Status	Single	26.8	73.2
	Couple	22.1	77.9
Employment	Students	28.8	71.2
	Employed	21.7	78.3

Table B.12 – Question 12

Characteristic		"€ 150" (%)	"Other answers" (%)
Overall		**32.6**	**67.4**
Gender	Women	29.2	70.8
	Men	38.5	61.5
Age (in years)	≤ 25	29.3	70.7
	25 < and ≤ 50	37.5	62.5
	> 50	32.7	67.3
Qualification	High School Degree	27.8	72.2
	Graduate	34.9	65.1
With/without kids	Without	31.7	68.3
	With	36.7	63.3
Marital Status	Single	30.4	69.6
	Couple	33.8	66.2
Employment	Students	28.8	71.2
	Employed	33.8	66.2

Table B.13 – Question 13

Characteristic		"€ 150" (%)	"Other answers" (%)
Overall		**61.8**	**38.2**
Gender	Women	57.3	42.7
	Men	68.5	31.5
Age (in years)	≤ 25	57.3	42.7
	25 < and ≤ 50	66.1	33.9
	> 50	67.3	32.7
Qualification	High School Degree	55.7	44.3
	Graduate	67.5	32.5
With/without kids	Without	60.7	39.3
	With	66.7	33.3
Marital Status	Single	58.9	41.1
	Couple	63.4	36.6
Employment	Students	55.8	44.2
	Employed	64.7	35.3

Table B.14 – Question 14

Characteristic		"€ 59 (Digital only)" (%)	"€ 125 (Paper only)" (%)	"€ 125 (Digital and paper)" (%)
Overall		**56.3**	**7.4**	**36.3**
Gender	Women	51.6	9.4	39
	Men	64.6	4.6	30.8
Age (in years)	≤ 25	59.8	4.9	35.3
	25 < and ≤ 50	55.4	11.6	33.0
	> 50	47.0	6.1	46.9
Qualification	High School Degree	57.5	9.3	33.2
	Graduate	56.0	6.2	37.8
With/without kids	Without	57.4	7.5	35.1
	With	51.7	6.7	41.6
Marital Status	Single	50.8	11.6	37.6
	Couple	59.2	5.2	35.6
Employment	Students	64.4	4.8	30.8
	Employed	53.1	8.7	38.2

Table B.15 – Question 15

Characteristic		"€ 59 (Digital only)" (%)	"€ 125 (Paper only)" (%)
Overall		**64.3**	**35.7**
Gender	Women	60.9	39.1
	Men	70.8	29.2
Age (in years)	≤ 25	68.3	31.7
	25 < and ≤ 50	58.9	41.1
	> 50	63.2	36.8
Qualification	High School Degree	71.1	28.9
	Graduate	60.8	39.2
With/without kids	Without	63.4	36.6
	With	68.3	31.7
Marital Status	Single	59.8	40.2
	Couple	66.7	33.3
Employment	Students	72.1	27.9
	Employed	61.4	38.6

Table B.16 – Question 16

Characteristic		"E.7" (%)	"Cards to be turned: 2" (%)
Overall		**2.2**	**53.2**
Gender	Women	2.6	55.2
	Men	1.5	50.8
Age (in years)	≤ 25	1.8	51.8
	25 < and ≤ 50	2.7	58.0
	> 50	2.0	46.9
Qualification	High School Degree	0.0	52.5
	Graduate	2.4	51.2
With/without kids	Without	2.3	54.7
	With	1.7	46.7
Marital Status	Single	1.8	51.8
	Couple	2.3	53.9
Employment	Students	2.9	22.1
	Employed	0.9	55.1

Table B.17 – Question 17

Characteristic		"Have the same colour" (%)	"The one on the right is lighter than the one on the left" (%)	"The one on the left is lighter than the one on the right" (%)
Overall		**55.7**	**3.1**	**41.2**
Gender	Women	56.8	3.1	40.1
	Men	53.8	2.3	43.9
Age (in years)	≤ 25	59.2	1.8	39.0
	25 < and ≤ 50	47.3	4.5	48.2
	> 50	63.3	4.1	32.6
Qualification	High School Degree	52.6	4.1	43.3
	Graduate	55.5	2.4	42.1
With/without kids	Without	55.8	3.0	41.2
	With	55.0	3.3	41.7
Marital Status	Single	55.3	0.9	43.8
	Couple	55.9	4.2	39.9
Employment	Students	60.6	2.9	36.5
	Employed	51.2	3.4	45.4

Table B.18 – Question 18

Characteristic		"A sequence where B is more likely than C" (%)	"A sequence with C more likely than B" (%)
Overall		**31.7**	**68.3**
Gender	Women	23.4	66.7
	Men	33.8	54.6
Age (in years)	≤ 25	30.5	59.1
	25 < and ≤ 50	24.1	48.8
	> 50	26.5	48.9
Qualification	High School Degree	30.4	64.1
	Graduate	28.2	60.3
With/without kids	Without	28.3	62.3
	With	25.0	60.0
Marital Status	Single	28.6	65.2
	Couple	27.2	60.1
Employment	Students	24.6	59.6
	Employed	33.7	63.3

Table B.19 – Question 19

Characteristic		"Bank teller" (%)	"Bank teller and feminist" (%)
Overall		**2.2**	**23.1**
Gender	Women	1.6	21.9
	Men	3.1	23.8
Age (in years)	≤ 25	1.8	22.6
	25 < and ≤ 50	2.7	22.3
	> 50	2.0	26.5
Qualification	High School Degree	2.1	24.7
	Graduate	1.9	23.0
With/without kids	Without	2.3	23.0
	With	1.7	23.3
Marital Status	Single	2.7	25.9
	Couple	1.9	21.6
Employment	Students	2.9	24.0
	Employed	1.9	23.2

Table B.20 – Question 20

Characteristic		"RGRRR" (%)	"GRGRRR" (%)
Overall		**9.9**	**84.3**
Gender	Women	8.9	84.4
	Men	11.5	83.8
Age (in years)	≤ 25	12.8	82.9
	25 < and ≤ 50	8.0	84.8
	> 50	4.1	87.8
Qualification	High School Degree	7.2	87.6
	Graduate	10.0	84.2
With/without kids	Without	11.3	83.7
	With	3.3	86.6
Marital Status	Single	10.7	87.5
	Couple	9.4	82.6
Employment	Students	14.4	78.8
	Employed	7.2	87.0

Table B.21 – Question 21

Characteristic		"Librarian" (%)	"Farmer" (%)
Overall		**68.3**	**31.7**
Gender	Women	69.3	30.7
	Men	67.7	32.3
Age (in years)	≤ 25	71.9	28.1
	25 < and ≤ 50	65.2	34.8
	> 50	63.3	36.7
Qualification	High School Degree	67.0	33.0
	Graduate	70.8	29.2
With/without kids	Without	68.3	31.7
	With	68.3	31.7
Marital Status	Single	70.5	29.5
	Couple	67.1	32.9
Employment	Students	70.2	29.8
	Employed	68.6	31.4

Table B.22 – Question 22

Characteristic		"Buy more" (%)	"Do nothing" (%)	"Sell some of it" (%)	"Sell everything" (%)
Overall		**10.8**	**32.6**	**37.8**	**18.8**
Gender	Women	12.5	36.5	33.9	17.1
	Men	8.5	26.9	43.1	21.5
Age (in years)	≤ 25	14.0	34.8	36.6	14.6
	25 < and ≤ 50	8.0	31.3	42.0	18.7
	> 50	6.1	28.6	32.7	32.6
Qualification	High School Degree	15.5	37.1	23.7	23.7
	Graduate	8.1	29.2	45.0	17.7
With/without kids	Without	11.7	33.6	39.2	15.5
	With	6.7	28.3	31.7	33.3
Marital Status	Single	8.0	33.0	43.8	15.2
	Couple	12.2	32.4	34.7	20.7
Employment	Students	17.3	32.7	33.7	16.3
	Employed	7.7	32.4	39.6	20.3

Table B.23 – Question 23

Characteristic		"Buy more" (%)	"Do nothing" (%)	"Sell some of it" (%)	"Sell everything" (%)
Overall		**19.4**	**62.5**	**11.0**	**7.1**
Gender	Women	16.1	64.6	13	6.3
	Men	24.6	59.2	8.5	7.7
Age (in years)	≤ 25	17.7	64	12.3	6
	25 < and ≤ 50	23.2	57.1	12.5	7.2
	> 50	16.3	69.4	4.1	10.2
Qualification	High School Degree	18.6	60.7	9.3	11.4
	Graduate	19.1	60.8	12.4	7.7
With/without kids	Without	19.6	60.7	14.5	5.2
	With	18.3	70	5	6.7
Marital Status	Single	17	66.1	9.8	7.1
	Couple	20.7	60.6	11.7	7
Employment	Students	14.4	63.5	14.4	7.7
	Employed	22.7	61.4	9.4	6.5

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