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Doctoral Thesis

Gamblers' Behaviour
a field investigation

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1 General Knowledge on Gambling

1.1 Introduction

Definition of Gambling

Pathological gambling is an addictive disorder characterised by a persistent and compulsive desire to engage in gambling activities. In 1980, the American Psychiatric Association officially recognised pathological gambling dependency as an impulse control disorder (third edition of the Diagnostic and Statistical Manual of Mental Disorders, DSM-III). In this first analysis, particular emphasis was given to the damage and disruption caused by this addiction to the individual's family and personal interests. In the following edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), pathological gambling was equated to substance dependence (DSM-IV). Recently, in the latest edition of the DSM, there is a reconsideration of pathological gambling. Today it is, in fact, considered an addiction (DSM-V), and no longer only an impulse control disorder. The parallels between gambling addiction and drug addiction have been underlined by experts for decades. However, only in the latest edition of the DSM can we find the first formal recognition of gambling as a behavioural addiction. This awareness is important for two reasons: firstly, because it makes gambling addiction treatable using similar approaches to the treatment of substance addiction; secondly, because it forces us to treat gambling as a good that cannot be sold in the market as a standard good, but instead has to be appropriately regulated like other potentially damaging products.

The context

Gambling nowadays constitutes a social plague, both for its diffusion and for the social costs it brings. Problematic gambling affects about 4% of the population worldwide (Hodgins et al., 2011). Italy represents the largest European gambling market and the fourth largest worldwide (according to a report released by Global Gambling Statistics, 2019). The growth rate of gambling in Italy is striking. In 2008, the gambling industry collected 47.4 billion Euros (about 3% of Italian GDP), while in 2017 this figure was 96 billion (about 6% of GDP), i.e. an increase of 104% (Amministrazione Autonoma dei Monopoli di Stato, 2017).

The reason for such astonishing growth is likely to be found in the myopic attitude of the governments who benefit by raising money from the gambling industries in a time of tight budget constraints. In fact, taxes amount to about 10% of the overall business in this industry, i.e.

about 10 billion Euros in 2017 [1].

At the same time, Italy allocates 50 million Euros each year to care for and prevent this type of pathology (Legge di stabilitá, 2015). Apparently, the benefits outweigh the costs. However, such a comparison is short-sighted and misleading because, while the benefits are immediate and certain, the costs are deferred into the future and very difficult to estimate. The underestimation of gambling's costs can be attributed to two main problems. The first problem lies in the difficulty of assessing the overall (monetary and non-monetary) costs associated with this problem. In fact, gambling entails several costs not directly related to treatment, such as health problems, depression, increased suicide attempts, and disruption of personal and work relationships. Most of such costs extend from the individual sphere to society in terms of job and productivity losses, higher dependency on the healthcare and welfare systems and increased default on debt, bankruptcies and inclination to crime (D. Collins and H. Lapsley, 2003; Griffiths, 2004) [2]. The second problem is the underestimation of the number of problematic gamblers. The 50 million Euro allocated to the treatment of problematic gamblers, in fact, refer to the gamblers currently in therapy, who are just the tip of the iceberg. Research by IPSAD-Italia (Italian Population Survey on Alcohol and Drugs) posits that the number of pathological gamblers in Italy is around 800,000 individuals, while only 12,000 are currently undergoing treatment. The problem is that studies of this phenomenon at the national level are scarce (F. Lucchini and D. Griffiths, 2015), and there are no official statistics from the Ministry of Health reporting the number of gamblers affected by this addiction. No one has, in fact, ever tracked gamblers behaviour by observing gamblers in their real environment. The current research fits into this context by studying the gambling phenomenon in Italy using a field experiment.

The study

The question of why rational people choose to gamble remained unsolved in economics studies for more than 200 years. By design, gambling is structured as an unfair lottery[3] where the odds are stacked in the bookmakers favour. Bookmakers, in fact, calculate the odds by designing a book in which the profit is around 20% of all the bets collected on a single race. This implies

[1] As further example, the reconstruction following the earthquake in Abruzzo in 2009 was financed by the release of several additional VLT licenses, (Ministero dell Economia, art.12 decreto-legge n. 39, 2009.

[2] A further problem at the social level is represented by the misallocation of resources, i.e. the shift of resources from more productive activities to gambling.

[3] In economics, "unfair lottery" indicates a lottery in which the expected return is not positive. Risk-averse individuals would normally reject this type of lottery.

that the odds are unfair (the expected return is not positive) and, in the long run, every gambler is destined to lose.

In the light of this, the main question is why problem gamblers persist in gambling despite overall negative return - a question that is not so straightforward. Economic literature has traditionally tried to find possible answers. When researchers want to investigate this question from an economic point of view they have to consider the evidences given by behavioural economics studies. In this context, behavioural economics tries to explain how and why subjects' behavior is not explained by the rational utility-maximization rule. Evidence, in fact, shows that subjects violate expected utility in systematic ways (C. Starmer, 2000) and that utility measurements based on expected utility give often inconsistent results (Abdellaoui, Barrios, and Wakker, 2007). Continuing to gamble despite repeated negative results may be attributed to the alteration of the decision-making process under risk.

Kahneman e Tversky, in 1979, developed one of the most important descriptive theories of decision under uncertainty (Prospect Theory). This theory explains the link between options and individuals' choices. For instance, it points out several possible explanations for why risk-averse people might choose lotteries with negative expected values. Some explanations refer to the concept of loss aversion. It tells us that subjects evaluate outcomes as gains and losses relative to a reference point and that they are more sensitive to losses than to gains; others tell us that probabilities are subjectively evaluated (often distorted); and finally some hold that the use of heuristics can lead to several cognitive distortions.

The current work intends to use notions of Prospect Theory with the aim of mapping the most relevant of gamblers' *behavioural traits* displayed when making risky choices. In the current text, with the term "behavioural traits" we include both risk and time preferences. We can consider as behavioural traits any observed individual's behaviour which can be defined entirely in terms of preferences[4]. Those traits influence our thinking and the way we feel about things and situations, and they reveal ourselves through the expression of preferences.

We choose to follow the notions proposed by Prospect Theory mainly because it allows us to disentangle gamblers' behaviour into several traits. In this way it will be possible to inspect separately which traits better predict gambling disorder.

In the Prospect Theory framework, in fact, there are some specific drivers of the individual's

[4]In the paper of Schmidt, U. and Zank, H., the authors mention the definition of loss aversion given in the original Prospect Theory as: "This clearly is a behavioral concept defined entirely in terms of preferences."(Schmidt, U. and Zank, H., 2005, pag.3).

decisions in contexts of uncertainty (e.g. risk preferences and loss aversion). Mathematically, these drivers can be captured by the shape of the utility function. This function assigns a real number to each possible outcome, which reflects the desirability of the outcome, and therefore the individual's preferences.

Following this framework, the present work takes into account, among other things, those behavioural traits that characterise the Prospect Theory's utility function, and it aims to measure them by focusing on a sample of real gamblers.

The objective of the first analysis (Chapter 2) is to investigate which trait, if any, matters the most in predicting gambling disorder. To do this, we compare the behavioural traits of problem gamblers to those of a group of non-problem gamblers. This comparison aims to contribute to our understanding of the behavioural traits that correlate with gambling addiction.

The analysis underlines differences between problem gamblers and non-problem ones, not only in terms of economic preferences, but also in terms of socio-economic conditions. This was achieved by collecting behavioural data, using incentivised experimental tasks, and gathering information regarding socio-economic status, using a self-reported questionnaire. This data was then correlated with participants' level of gambling disorder obtained by using official medical criteria (questionnaire DSM-V).

However, correlation cannot tell us the direction of causality. For instance, if we observe that the more risk-seeking people are also the more addicted ones, it is not possible to determine what caused what. It could be the case, for example, that people who are more risk-seeking are also more gambling addicted because of their natural attitude to risk. It could be, instead, that more addicted people show risk-seeking preferences because their gambling activity has changed their preferences over time.

In this light, the second part of this study (Chapter 3) aims to inspect this possible causality between gambling disorder and behavioural traits. To do this, we tested the most salient traits before and after a tracked session of gambling activity. An exogenous treatment was used to avoid self-selection issues. The method limited the amount of time subjects spent gambling. This amount of time was randomly decided by the researcher, by stopping the gambler's activity after one or four hours. Indeed, if the participant was not randomly stopped it would be impossible to determine if a change in the behavioural traits was due to the activity of gambling or to some specific characteristic of the participant which at the same time was leading him to gamble for more or less time and also to change the trait. In other words, without a random treatment the duration of the gambling activity would be endogenous. The different and random length of gambling time allowed us to observe whether a longer time spent gambling impacted the gambler's preferences differently.

The added value of the current work lies also in the fact that the majority of behavioural traits considered relevant in the gambling literature were simultaneously taken into account. In addition, gamblers were followed during a real gambling session, collecting all the data relative to their actual gambling behaviour. This close observation of gamblers in "action" is extremely difficult to achieve, since betting agencies are usually permeated with strict privacy rules. As proof of that, very few data are available at the individual level regarding gamblers' behaviour in their actual settings.

This work proceeds as follows: Chapter 1 discusses the economic literature and describes experimental procedures to measure behavioural traits; Chapter 2 presents the first analysis, underlining behavioural and socio-economic differences between problematic gamblers and non-problematic ones; Chapter 3 presents the second analysis, addressing causality between gambling activity and the variation in levels of the behavioural traits.

1.2 Behavioural Economics and Prospect Theory

The study of gambling involves several branches of knowledge, such as medicine, neuroscience, biology, psychology, sociology, and economics. Biological approaches highlight the importance of genetic factors, and neuroscience focuses on the brain's responses, whereas psychological and economics studies focus on behavioural features and on the decision-making processes.

Each discipline investigates the phenomenon using different levels of accuracy according to its objectives and methodology. In particular, economics address the phenomenon by focusing the attention on the decision-making processes.

Many years of studies have been devoted to developing various mathematical models which describe how individuals take their decisions. Within these studies, the approach of Behavioural Economics is based on the economic scientific analysis of the decision making process, drawing on methods from psychology, sociology and neurology.

The normative Expected Utility Theory has been for several years the dominant model to describe the decision making process under uncertainty. However, empirical evidence has shown that the theory does not provide an adequate description of individual choice. Decision makers systematically violate its basic assumptions.

Many alternative models have been proposed to try to resolve the discrepancy between theoretical assumptions and empirical evidence. One such is the model proposed by Kahneman and Tversky in 1979 (Kahneman and Tversky, 1979) and then improved in several subsequent editions (Tversky and Kahneman, 1986, 1992). In the present study we refer to this model mainly because it allows us to observe the individual's behaviour using several dimensions. In this model, in fact, at least four parameters describe the individual's decisions under uncertainty. Three of them give the shape of the utility function and the other one (at least) describes the probability weighting function.

Prospect theory is based on three main concepts. The first is that individual choices are evaluated relatively to a reference point. The second claims that losses and gains are perceived with different intensity (losses hurt more than gains feel good). This last phenomenon is called *loss aversion*. The last important concept is *probability distortion*, which implies that humans evaluate objective probabilities in a subjective way[5] (Kahneman and Tversky, 1979). The value

[5]Generally, people overweight small probabilities and underweight moderate and high probabilities

function is commonly assumed with a specific shape: concave for gains, convex for losses. This feature expresses the empirical evidence that people are generally risk averse in the gain domain and risk seeking in the loss domain. Moreover, the value function is often assumed to be steeper for losses than for gains, and this reflects the loss aversion phenomenon.

In the present work we will take into account all these concepts, and add to our analysis some other behavioural dimensions which are considered relevant in the study of the decision making process from a behavioural economics perspective (e.g. cognitive distortions and time preferences).

As mentioned before, in the present text we will use the term "behavioural trait" to indicate any behavioural dimension, within the behavioural economics context, which drives the individual's decision. Even if these traits are not directly measurable, we can deduce and measure them by observing the subjects' choices, which are the expression of the individual's preferences. In a recent work of P. Ring et al., they use the term "risk preferences" to indicate the risk attitude in the gain and the loss domains, the weighting of probabilities, and the degree of loss aversion (P. Ring et al., 2018, pag. 2). In the present work, we use the term behavioural traits with the aim of including, besides that, also time preferences and ambiguity aversion.

The most important behavioural traits are described below, as well as the method used to measure them in our experiment.

Although we refer to the model specified in the Prospect Theory framework as the basis of our study, the general part of our analysis does not rely on this theory, but is based on the analysis of certainty equivalents. Our analysis will not estimate each parameter of the utility function. Indeed, due to the design of each task, we obtained a single point of the value function per subject in the gain and in the loss domain respectively. A single point of the value function allows us to calculate the value of the parameter related to just a short piece of the function's curve. In the light of this, we use, in most of the cases (depending on the structure of the task), the certainty equivalent [6] as the measure of the level of the behavioural trait inspected.

[6] In economics literature the term "certainty equivalent" indicates the amount of payout that an agent need to receive to make him indifferent between that payout and a given lottery. In the multiple prize list method, which is often used to estimate people's preferences, the certainty equivalent is very close to the switching point. The switching point is the amount of payout that makes the participant move from one option (often a lottery) to another (often a certain amount).

1.2.1 Behavioural Tasks - Prospect Theory Context

Before outlining behavioural traits and their method of measurement, we now give a brief overview of Prospect Theory (Kahneman and Tversky, 1979). This theory was the starting point for our analysis and we based on this framework our hypotheses.

Let us assume that a lottery has a finite probability distribution over a set of monetary outcomes. We can represents it as P := (p1,x1;...;pn,xn). It indicates that p1 is the probability that the outcome x1 happens. The sum of the probabilities is 1 and probabilities are non negative.
The expected utility tells us that:

$$EU(p1, x1; ...; pn, xn) = piU(xi) \tag{1}$$

Where U is assumed strictly increasing and continuous with U(0) = 0.
According to the Prospect Theory's framework, it has also the following properties:
1. u(.) is convex for $x < 0$ and concave for $x > 0$, This property represents the empirical evidence of risk aversion in the gain domain and risk seeking in the loss domain.
2. fair symmetric games are refused (if compared with the status quo): $u(x) < -u(-x)$, $x > 0$;
3. $u'(x) < u'(-x)$, $x > 0$.

In the present study we will use the power S-shaped utility function (Benartzi and Thaler, 1995; Tversky and Kahneman, 1992; Wakker and Zank; 2002).

$$f(x) \begin{cases} u(x) = x^{\alpha}, & if \quad x >= 0 \\ u(x) = -\lambda(-x)^{\beta}, & if \quad x < 0, \end{cases}$$

Notice that, when $0 < \alpha <= \beta < 1$ the individual's utility function expresses risk aversion in the gain domain and risk seeking in the loss domain. Moreover, $\lambda >= 1$ makes the shape steeper in the loss side, thus expressing loss aversion.

Below, we define more precisely these traits and their method of measurement.

- **Risk aversion** *is the measurement of to what extent an individual refuses a risky prospect in exchange for a certain amount equal to or lower than the expected value of the lottery.*

The study of risk preference allows us to inspect firstly gamblers' attitude towards the risk, and second whether gamblers show different levels of risk aversion when they face gains and losses. This last point is captured by the parameters α and β in the model showed above. For example, it is often common to find that the shape of a value function is asymmetric: convex in the loss domain (implying risk-seeking) and concave in the gain domain (implying risk aversion) (Kahneman and Tversky, 1979). Finally, the study of risk' preferences can inspect whether gamblers show diminishing sensitivity propensity. This trait is a phenomenon which implies that the level of risk aversion of an individual decreases/increases as the level of losses/gains increases. In particular, empirical studies seem to suggest that diminishing sensitivity patterns could discriminate gamblers from non-gamblers (Richard H. Thaler, Eric J. Johnson, 1990). This means that after having collected a certain amount of losses, gamblers start to display higher risk-seeking rates than those shown by non-gamblers.

All these patterns concerns human behaviour when facing general situations involving risk. However, when studying problematic gamblers, these patterns seem to be even stronger (A. Genauck et al., 2017).

In order to measure risk aversion we used two different tasks. The first method is known as "Multiple Price List" (MPL). The aim is to determine the certainty equivalent of several gambles. In the specific case of risk aversion, we made the subject choose between two options. The first was fixed and concerned a risky option (a lottery with a known probability). The second option was a specified range of increasingly valuable prizes ordered in a table, one per row. The subject had to make a choice for each row: to choose to play the risky option or to take the certain amount of money. The technique was based on the certainty equivalent procedure (Kahneman and Tversky, 1992) and the switch point of the subject told us the indifference point between the guaranteed value and the risky option. The lotterys certainty equivalent was calculated as the arithmetic mean of the certain amount preferred to the lottery and the previous certain amount on the list. (see the specification of the task in Appendix 1).

The second task that we adopted to elicit risk aversion level was a task designed by Crosetto and Filippin (BRET, 2013), named "Bomb Risk Elicitation Task". The main difference from the MPL method is that the BRET method does not have a safe option. The task consists of asking subjects at which point to stop collecting a series of 100 balls, when one of these balls contains a bomb (black ball). Earnings increase linearly with the number of balls collected, but are zero if one of the balls collected contains the "bomb". Subjects are free to choose any number of balls between zero and one hundred.

- **Loss aversion** *expresses the tendency of humans to dislike losses more than they like equivalent gains.*

  This tendency is one of the crucial ingredients of Prospect Theory. Kahneman and Tverskys (1979, p. 279) define loss aversion, saying that: an individual is loss averse if she or he dislikes symmetric 50-50 bets and, moreover, the aversiveness to such bets increases with the absolute size of the stakes. In the framework of Prospect Theory, loss aversion is expressed only by the utility function, which is steeper for losses than for gains. As shown in the model above, λ captures this trait. Previous research has examined loss aversion among gamblers, finding it to be a heterogeneous phenomenon (H. Takeuchi et al., 2016). It seems, in fact, that the more pathological gamblers are those with higher and lower levels of loss aversion compared with the whole sample. In other words, the recent study of H. Takeuchi et al. shows that pathological gamblers are characterised by extreme levels of loss aversion: some of them are extremely loss averse and some others are extremely loss lover. Healthy subjects, instead, usually show moderate levels of loss aversion.

  Our experiment tested loss aversion levels using the MPL method involving real money (see previous task). In the loss aversion task we adopted a mixed lottery (50% chance of winning 25 Euro and 50% chance of losing 25 Euro) as the risky option (see the specification of the task in Appendix 1) and a certain amount that varies between 20 Euro to -20 Euro. The certainty equivalent of the lottery was calculated as the arithmetic mean of the first certain amount chosen instead of the lottery and the certain amount immediately lower. The use of the MPL method involving mixed lotteries is quite common in the measurement of this trait (H. Takeuchi et al., 2016, Abdellaoui, et al., 2008; V.Gelskov, et al., 2016). Indeed, we are interested in observing the different steepness of the utility function moving from the gain domain to the loss domain. For instance, the utility function is characterised by a kink (a point of non-differentiability) that distinguishes gains from losses.

The main problem with the use of this method is that risk aversion could also play a role in explaining the individual's choice in this task. We cannot be sure, in fact, whether a person chooses the status quo (win 0 and lose 0) instead of playing the lottery (with an expected value of 0) because he/she is loss averse or because he/she is risk averse. In this regard, according to the definition given by Kahneman and Tversky [7], it seems that loss aversion carries more weight in explaining this type of decision. Moreover, we have to consider that when the lotteries concern a ranges of such small stakes (-20, -10, -5, 5, 10, 20) the preference for a safe option due to risk averse behaviour should imply that when the decisions concern larger stakes then the risk aversion level would be extremely high. In other words, risky choices in small stakes cannot express risk aversion, or otherwise it would imply unreasonably high degrees of risk aversion for large stakes (Rabin, 2013). However, since we have the individual measures of risk aversion in the gain and in the loss domain respectively (see previous task), we use these measures to control/purge the result of the loss aversion task (see Section 2.5.2.).

- **Probability distortion** *is the human tendency to evaluate probabilities in a subjective way.*

  When humans face risky prospects, they usually tend to over-weight very low probabilities and to under-weight very high probabilities. In the framework offered by Prospect Theory, this tendency is captured by a function called probability weighting function, which links objective probabilities to subjective ones. The subjective probabilities can be deduced from subjects' choices. Researchers have employed several methodologies to estimate the probability weighting function. Most of them report that this function is concave below some probabilities (typically below 0.3) and convex above them (typically above 0.6) (Camerer, C. F., and Ho, T. H., 1994; Kahneman and Tversky, 1992). Empirical evidence suggests that probability distortion appears greater near the endpoints 0 and 1 than near the middle of the probability scale.

  In general, probability distortion has to be evaluated in studies concerning risk aversion. For instance, some researches (P. J. Grossman and C. C. Eckel, 2015; J. Golec, J., and

[7] "An individual is loss averse if she or he dislikes symmetric 50-50 bets" Kahneman and Tversky, 1979, p. 279

M.Tamarkin, 1998) report that players are risk averse, but in case of low probabilities of winning (high payoffs), they behave as risk-loving subjects. This behaviour could be explained in two ways: it could be that the subjects are risk-loving in a low probability scenario because they are overestimating the probability, or because they are very attracted to big wins (T. Garrett and R. Sobel, 1999; J. Grossman and C. Eckel, 2015). On the contrary, other studies found that gamblers are more risk-loving than healthy subjects independent of the size of the probability. For instance, R. Ligneul and his colleagues confirmed these results by comparing pathological gamblers with healthy subjects (R. Ligneul et al., 2012).

In our case, we used a very simple task that does not allow us to derive the whole probability weighting function. However, since gambling often involves very low probability, we were interested in estimating probability distortion within only a very small range of probabilities (1% to 8%). This decision is driven by the fact that the experiment we carried out concerns several behavioural dimensions and it took a long time to do. We, therefore, restrict our focus to this small ranges of probabilities.
Specifically, we used the MPL task using real money, in which the fixed option was a certain amount of money, and the other option was a defined array of increasing probabilities ordered in a table, one per row. The subject had to make a choice for each row: choosing to take the lower and certain amount of 25 Euro or choosing the risky option that gives a higher amount (300 Euro) with a probability that varied from 1% to 8%. Note that a risk-neutral subject without probability distortion behaviour should always choose the certain amount since the expected values of the risky options are always lower than 25 Euro. This method is quite similar to those used in the relevant literature (Kilka, M., and Weber, M., 2001; Gonzalez, R., and Wu, G., 1999). In fact, it allows us to determine the probability which makes the participant indifferent between taking the certain amount and play the lottery. A more detailed description of the task can be seen in Appendix 1.

1.2.2 Additional Behavioural Task

In the present study, we add to our analysis some other traits, in addition to those that characterise Prospect Theory context. The analysis takes into account those traits that are considered relevant in the study of the gamblers' behaviour. We briefly present them below.

- **Ambiguity aversion** *refers to the tendency to avoid situations of uncertainty in which the probabilities are unknown.*

  Usually, risky prospects refer to situations involving given probabilities. However, often, in a gambling scenario, probabilities are unknown or hard to estimate correctly. In this regard, several empirical studies, inspired by Ellsberg (1961) and others, have shown that subjects prefer to bet on events they know more about (C. C. Eckel and P. J. Grossman, 2008). This behaviour is called ambiguity aversion.

  We addressed this point by using a simple task inspired by Ellsberg's experiment. The participants were faced with three urns: the first urn contained coloured balls of a known composition, and therefore participants knew what probability they had of drawing the winning ball (0.33). For every row, they had to choose whether to draw a ball from the urn or play the lottery with a given probability (for every decision the probability of winning in the lottery increased). This first urn with the known composition of balls helped us to ensure that the participant understood the task. If he/she did, then his switching point should be at the lottery that gave a winning probability of 0.33. The other two urns contained coloured balls of an unknown composition. Therefore, in these cases participants did not know what the probability was of drawing the winning ball. As before, the switching point told us the indifference point between drawing the ball from the urn and playing the lottery with a given probability (as mentioned above, for every decision the probability of winning in the lottery increased). Therefore, we could identify the probability they attached to the ambiguous events. The task is shown in detail in Appendix 1.

  This method is a variation of the well-known Ellsberg Experiment, which is one of the most common method used to elicit ambiguity aversion in the lab-experiment context (Camerer, C., and Weber, M., 1992).

We translate the result of the task using the following index:

$$i = (0.33 - (pb + py)/2) * 100$$

Where:

- 0.33 indicates the probability of drawing the winning ball from the know urn composition.
- pb is the probability they attach to the possibility of drawing the winning ball from the unknown urn composition (that containing blue balls).
- py is the probability they attach to the possibility of drawing the winning ball from the unknown urn composition (that containing the yellow balls).

Under ambiguity neutrality, participants should attach a probability of 0.33 to "drawing" the winning ball from both the unknown urns. Therefore, pb=0.33 and py=0.33, and i=0. Maximal ambiguity aversion occurs for $i = 10$, when participants evaluate the probability of drawing the winning ball from the unknown urns as very low [8]. Ambiguity aversion is minimal for i= -10, when participants evaluate the probability of drawing the winning ball from the unknown urns as very high.[9]

- **Time preferences** *express the different utility that people attach to present consumption compared to the same consumption in the future.*

  The tendency to discount delayed rewards at high rates is also known as impulsivity. Two points are particularly relevant when researchers want to investigate timing and latency related to the gambling context: first, the existence of present bias, which leads individuals to over-appreciate rewards that occur in the present time compared with the same reward located in the future (E. A. Ok and J. P. Benot, 2007). Behaviourally speaking this tendency is also named impulsivity. The level of impulsivity is found to be significantly stronger for gamblers. It is, in fact, one of the most salient trait that discriminates gamblers from non-gamblers (N. M. Petry, 2001). Secondly, Griffths and Harris (A. Harris and M. D. Griffths, 2018) inspect timing by considering it a game's feature. They state

[8] In our experiment the lowest probability they can choose is 0.23

[9] In our experiment the highest probability they could choose was 0.43

that, in a gambling scenario, faster games, in term of payout, are those that result in being more addictive because the speed of the game is able to rise impulsivity leading to an overvaluation of immediate rewards.

We tested time preferences using the MPL method. In this case, the tasks were not incentivised due to the difficulty of paying a participant in the future. Time preferences were eliciting for both gain and loss domains, taking into account three different time horizons: today - tomorrow, today - one month, and tomorrow - one month. The reward of the earlier option was always 50 Euro, and the delayed reward amount was increased/decreased with a series of interest/discount rates (the same for each time horizon). The three time horizons allowed us to identify: first, whether future gains and future losses are valued in a different way; second, the existence of present bias, which implies that participants display higher impatience when there is the possibility of receiving the reward today (over-weights immediate rewards). Third, the existence of quasi-hyperbolic discounting, which happens when subjects do not show the same interest/discount rate over time, but instead, the interest rate reduces as the delay increases.

- **Cognitive distortion** *is a systematic pattern of deviation from rationality in judgement.* Cognitive distortion often occurs when people use heuristics when they have to take decisions. Heuristics is a particular approach to problem-solving that use mental shortcuts to make decisions. The use of mental strategies in order to take quick decisions often increases the occurrence of fallacy in judgement (E. E. Fortune and A. S. Goodie, 2012). The representativeness heuristic has been used to explain two opposite expectations, which often occur when people face random sequences. The first type of expectation refers to positive recency (hot hand fallacy). The second type refers to negative recency (gambler's fallacy). Both happens when people estimate the probability of a certain outcome basing their perceptions on previous outcomes, even if every event is statistically independent. Hot hand fallacy leads people to think that after a sequence of a given outcome, this has to continue. Gambler's fallacy, on the other hand, is the opposite. After observing a given outcome, people think that this outcome has a lower probability of happening in the subsequent cases. There is more than one explanation of this phenomenon. For example, the gambler's fallacy could reflect the expectation that arises when a finite population of outcomes is sampled without replacement. Under this circumstance, the gambler's fallacy expectation would have validity because the probability of observing a particular outcome lowers if it has happened in the previous cases. A different vision is offered by Kahneman and Tversky (1972). They give us a cognitive explanation of the phenomenon (representativeness heuristic). In this vision people believe that the essential characteristics of a chance process have to be represented not only globally in an entire sequence of random outcomes but also locally in each of its parts.

What could be interesting is to understand what drives these two opposite expectations. In this regard, Ayton and Fischer (2004) try to explain in which circumstances we can observe positive or negative recency. They hypothesise that when subjects believe that a sequence of outcomes reflects human performance, then we observe positive recency expectations. But when subjects believe that outcomes are due to an inanimate mechanism, then the expectations indicate negative recency (Ayton, P., and Fischer, I., 2004). We choose to inspect the presence of such "erroneous" expectations because these are quite common in the gambling scenario. For example, in the basketball games context, the tendency of people to believe that a player who has just scored several times is now more likely to score because he or she is lucky or "hot" (Gilovich, T., et al., 1985).

The gambler's fallacy, by contrast, could explain a particular pattern observed in the study of risk aversion (G. Xue, el al., 2011): the tendency of gambler's risk aversion to vary over time during the gambling session. This trend could be explained by the influence of the previous outcomes on their estimation of probabilities.

We test the presence of this distortion by asking participants to choose an amount of money they want to bet in a coin-toss game, showing them different series of past outcomes. In this way, it is possible to control whether past outcomes influence the actual gambling decision. This specific task allows us to observe different possible behaviours. First, the gambler stakes the same amount of money in each coin-toss game proposed, irrespective of the past outcomes: this means that he is not influenced by them. Second, he is influenced by past outcomes. In this case he can either bet more money on the event that has occurred fewer times (gambler's fallacy) or on the event that has occurred more frequently (continuation or hot hand). The third case is when the player is not influenced by past outcomes and he stakes random amounts each time (rollercoasting).

1.2.3 Gambling disorder measurement

The most crucial information we need for our analysis is the level of gambling disorder. Pathological gambling is considered an addictive disorder characterised by a persistent and compulsive desire to engage in gambling activities and it is equated to substance dependence by the American Psychiatric Association (APA). APA has developed a questionnaire to inspect the relationship that gamblers have with gambling activity: the Diagnostic and Statistical Manual of Mental Disorder 5th Edition (DSM-V). We decided to use this classification because it is the most authoritative instrument to assess the entity of gambling disorder. The DSM is, in fact, the primary classification system for diagnosing mental disorders in the United States, and it is widely used in many others countries (Petry, N. M., 2010).

In the last version of the DSM (DSM-V), gambling disorder is included in the section related to substance-use disorders. Gambling and substance-use disorders, in fact, show similar symptoms (Petry, N. M. 2006; Toce-Gerstein et al. 2003) and genetic vulnerabilities (Blanco et al. 2012; Slutske et al. 2000). In addition, both are associated with similar biological markers and cognitive deficits (Blanco et al. 2012).

The questionnaire refers to the patients' gambling attitude in the last year. It analyses sensations and fears, but also the presence of specific behaviours that characterise an addicted gambler. It inspects the existence of nine specific symptoms which need to be present in order to consider the subject a problematic gambler. In particular, the dimensions detected refer to possible damage to the family, a job, or an educational or career opportunity because of gambling. The questionnaire also inspects the need of gambling with increasing amounts of money, the irritable feelings and eventual unsuccessful efforts that gamblers experience when they have to stop gambling. Furthermore, it inspects the preoccupation, anxiety and depression they have concerning their gambling activity, the common tendency to "chase" one's losses, and lastly the habit of asking for money from others to relieve desperate financial situations. In our version of the questionnaire, the subject has to indicate the frequency of each of the nine items' occurrence (never, once, sometimes, or often). The complete version of the DSM-V can be found in Appendix 1. We used this instrument to define every subject in our sample as either a problematic or a non-problematic gambler (and the severity of the gambling disorder). The American Psychiatric Association has set the number of symptoms which are required in order to classify a subject as problematic gambler at four. However, some researchers have suggested that the threshold for diagnosis should be reduced down to three, two, or even one criterion (Mitzner et al. 2011). This suggestion is driven by the fact that lowering the symptoms required would help to diagnose and treat more individuals who may be experiencing even a mild degree of gambling problems.

This session has briefly explained the economic behavioural traits we considered and the instruments we used in our study. The next section will describe in detail the design of the experiment and the subject pool. It should be borne in mind that these last two components are common to both of our analyses.

1.3 Experiment Procedure

The data for this research was collected through a field experiment. The experiment aimed to capture *behavioural traits* of a group of real gamblers before and after a session of gambling, observing them in the betting venue they usually frequent. The data was collected from three sources: experimental tasks, self-reported questionnaires, and observation of the subjects' gambling behaviour. It is divided in three parts that started and ended within the same day. The data was collected from October 2018 to March 2019.

1.3.1 Experiment location

The experiment took place in one historic and central betting agency in Milan (SNAI). It is frequented by dozens of people every day, with peaks at the weekend of hundreds of clients simultaneously. To give an idea of the revenues and the number of the transactions occurring in the betting agency, Table 1 shows the statistics for 2017.

Table 1: Statistics about the betting Agency (2017)

Type of game	N. tickets*	Tot. Revenues (Euro)	Rate of Payment**
Sport bets	146885	2.015.308,65	76,71
Virtual races bets	469822	1.109.366,20	83,10
Horse races bets	130165	923.132,00	68,37
Total	**746872**	**4.047.807,10**	**76,42**

* *N. tickets* indicates the number of bet receipts emitted per year
** *Rate of Payment* indicates the percentage of the revenues that are given back through winnings

In the gambling venue there are five counters, where customers bet directly by speaking to a counter clerk. The customer, for each bet, receives a receipt for the bet which contains the following information: type of game, specification of the race/matches, expected result, odds relative to the results (only for fixed odds games), amount staked, potential winnings (only for fixed odds games), time of the bet.

There are dozens of TV screens on the agency's walls showing the main events. The horse races and the virtual events of the day are all broadcast by the agency. Meanwhile, another couple of TV screens stream live the main sport events of the moment (mostly soccer, then tennis and basketball). In a secluded room of the agency are located slot machines and VLT (videolottery) terminals. All the windows of the agency are obscured with window stickers and posters, thus making artificial lights the only lighting source in the agency.

Betting games offered by the agency are listed below:

Horse racing: Classic horse races, trotting or galloping. The events are real horse races located in different places, mostly in Italy.

Possible bets: Win (horse comes first); place in two (horse comes in the first two); place in three (horse comes in the first three); pair (first *and* second horses); trio (first, second *and* third horses).

Events frequency: During racing hours (from 2 p.m. to 7 p.m. approx.), there is a race every 10 - 15 minutes. Each race lasts about 4 - 5 minutes.

Payout timing: From 10 to 30 minutes after the end of the race.

Odds: The odds are not fixed, since they are calculated at the end of the race based on the total amount staked at national level. For this reason, the final odds are shown only at the moment of the payout (10 to 30 minutes after the end of the race). Before the race, gamblers can see on the monitor just an estimation of the *win* odds of every horse, updated about every minute. Some pair and trio combinations' estimated odds are shown on the monitor in the minutes before the race. We can consider this type of game ambiguous in terms of probabilities. Note that the structure of the bookmakers' system does not allow us to see the odds for losing tickets, since the system gives the official odds only for the winning combinations. We decided to overcome this limitation by re-calculating the odds of all of the *horse race* bets (winning and losing). To do this we built an algorithm based on conditional probability estimation.

Skill involved: Some information regarding the horse racing world (history of the horse and the jockey, type of terrain and previous performance), can be used by the gamblers to make a betting choice. Like other major sports, such as soccer, there are some newspapers that write about horses, jockeys and races. This implies that this type of game requires the use of some kind of skill and knowledge, and interaction among gamblers.

Virtual bets: Simulated dog/horse/motor races; simulated football matches.

Possible bets: For races: win; place in two; place in three; pair; trio.

For football matches: 1-X-2 bets; Goal/noGoal; under/over; exact result of the match; various other bets.

Events frequency: On average there is a race/match every minute (two events can take place simultaneously). Events are broadcast from eight in the morning until midnight.

Payout timing: The winnings can be instantly paid as soon as the event ends.

Odds: The odds are fixed and displayed in the minutes before the event. For every race there is the same "scheme" of odds (the favourite with odds of 1.3/2, the one with odds of 4/5, the underdog with odds of 18/20 and so on...). We can consider this game non-ambiguous in terms of probabilities.
Skill involved: There is no information or knowledge that can help gamblers to make a choice. Since the events are computer simulations, odds in the medium-to-long run are directly related to the probabilities. For these reasons, virtual games are similar, in their functioning, to slot machines.

Sport bets: Bets on the classic sport matches. Football (90% of the sport bets), tennis, basketball, and many other sports. From the national leagues to the minor divisions.
Possible bets: 1-X-2 bets, number of goals, exact result and a multitude of others types of bet.
Events frequency: Usually gamblers bet on matches that take place that very evening or on the major matches that will take place the following weekend.
Payout timing: The system unblocks the payout of a sport ticket a couple of hours after the end of the event. However, the majority of sport gamblers return to cash in their tickets at least a day after they bet (they have 60 days to cash the tickets).
Odds: The odds are fixed. During the days before a match, the odds can fluctuate due to the amount staked at national level, but the odds that matter for the gambler's ticket are those shown at the moment of the gamble. We can consider this game non-ambiguous in term of probabilities.
Skill involved: Lots of information is evaluated by gamblers before setting up the bet (previous results of the teams, position in the ranking, etc.). This requires the use of some kind of skills and knowledge, and interaction among gamblers.

Sport live bets: Betting on real sports matches during the course of the event.
Possible bets: The same bet types as sport bets. In addition gamblers can bet on in-match bets such as: "which team will score next", "minute of the next goal", etc.
Events frequency: During the day there are almost always some matches that gamblers can live-bet on. Obviously this kind of bet is carried out the most during evenings and weekends. Most of them are broadcast on the agency's TV screens.
Payout timing: Payout time is fast: for in-match bets ("who scores next" etc.), tickets are cashed

before the end of the match. For the standard bets (1-X-2 bets, etc.) tickets are cashed five to ten minutes after the end of the match.

Odds: Even if the odds vary a lot in a matter of minutes, they are fixed at the moment when the bet is placed (no ambiguity).

Skill involved: Beside the "sports knowledge" already mentioned in the section on sports bets, gamblers have to watch the match and "read it" to guess what will happen. In addition, it is very important to choose the right moment to place the bet to get higher odds. Given this, among the games taken into account in our study, *sport live bets* involves the most skill.

Slot machines and Videolotteries (VLT): Slot machines work only with coins and reward with coins. VLTs are networked and prizes are calculated and distributed at a national level. VLTs accept banknotes. Note that these two are the only games in the agency that do not issue a receipt for the bet. For this reason, the only way we could track it was via a self-reported questionnaire. These machines are physically located in a designated area of the gambling venue.

Possible bets: Gamblers operate a button to spin the reels. They can decide how many "lines" they want to bet on.

Events frequency: Gamblers can spin the reels literally every 2 seconds. Furthermore, they can bet on many lines simultaneously for every spin.

Payout timing: Immediate. It is the fastest game we found in the agency.

Odds: Even if odds are, theoretically, given (regulations and guidelines), they are very difficult to quantify and to estimate in the moment of the gamble. For this reason we consider this game to be ambiguous in term of perceived probabilities.

Skill involved: It does not involve any skills or knowledge, or interaction between gamblers. On the contrary, it leads to significant isolation.

1.3.2 Experiment Design

Introduction

The experiment was divided into three parts that started and ended within the same day. The first part consisted of a questionnaire that explored behavioural traits and socio-economic conditions. After that, gamblers were allowed to gamble freely in the agency with their own money and, after a specified amount of time, in the third part of the experiment we retested some of the behavioural traits and asked participants to answer some other questionnaires.

Thanks to the segmented structure of the experiment we were able to collect a wide range of original information, from both experiments and observation of the actual behaviour of gamblers. The experiment part was carried out through a series of incentivised behavioural tasks. The tasks comprised a series of binary choices, in which the participants had to choose between a fixed amount of money and the possibility of playing a lottery with various probabilities (known or unknown). Subjects were informed that at the end of the experiment, one of the tasks was randomly selected and played for real, and the participants would be rewarded accordingly. In this way, every decision might determine the amount of money that the participant could win, ensuring that each of them is perceived as "real". Due to the nature of the behavioural traits considered, the fact that every decision was perceived as "real" was extremely relevant to ensuring we obtained a truthful decision. In this regard, several studies state the importance of using incentivised tasks when preferences are elicited in a laboratory (Holt and Laury, 2002). The implication of non-incentivised behavioural measures is that choices are perceived as unrealistic and therefore not useful in measuring the risk attitude as it would be in the "real" world (this also happens when very small stakes are involved) (Kahneman and Tversky, 1979, pag 265).

Approaching the participants

The researcher, in accordance with the agency director, sets up a desk in the venue's main room and asked customers that entered the agency (before they started to gamble) if they wanted to participate to the experiment. At first, the customers were told that the experiment could take up to five hours (in reality 50% of people stopped after 1 hour and 50% after 4 hours). Participants could, of course, leave whenever they wanted during the experiment but if they did they would give up their compensation (note that no participant gave up the experiment before the end). Participants were told about the conduct of the experiment by having the instructions read with them and an example task performed with them. In addition, for every choice, the researcher accompanied the gamblers, reading and explaining every task, and showing participants the containers filled with colored balls which emulated the lotteries. The whole text of the instructions for the experiment is shown in Appendix 1.

First part of the experiment

After the explanation of the whole experiment, the participants began the first part. The researcher gave every participant a booklet in which were printed all of the tasks, the questionnaires, and the instructions. The first part consist of 14 behavioural tasks and a socio-economic questionnaire. The majority of the tasks consisted of a series of questions with a binary choice. The tasks were used to test behavioural traits of the subjects, using the methods discussed in more detail in Section 2. After the tasks, every subject had to respond to a questionnaire about his/her socio-economic status. The average time required for completing this first part was 20 minutes (excluding instruction and explanation).

Behavioural traits measured are listed below (with the method used):

- ambiguity aversion (MPL, inspired by Ellsbergs experiment)
- risk aversion in the gain domain (MPL, BRET)
- risk aversion in the loss domain (MPL, negative expected value lottery)
- loss aversion (MPL, mixed lottery)
- probability distortion (MPL)
- gambler's fallacy (coin-toss game)
- time preferences in the loss domain and in the gain domain (MPL)

Socio-economic variables:

- Age
- Number of children
- Employed: dummy variable. 0=unemployed; 1=employed
- Retired: dummy variable. 0=non-retired; 1=retired
- Single: dummy variable. 0= married or engaged; 1= neither married or engaged
- Income: 1= 0/10,000 Euro/year; 2=10,000/20,000 Euro/year; 3=20,000/50,000 euro/year; 4= over 50,000 Euro/year
- Education: 1=no education; 2= Primary school; 3= Secondary school; 4= Graduated; 5= beyond
- Happiness: Choice from a scale from 1 to 10
- Life satisfaction level: Choice from a scale from 1 to 10
- Religion: Protestant; Jewish; Catholic; Muslim; Others; Non-Religious

Nationalities are investigated via open question and were then grouped in the following categories.

- Italian

- East-Europe: Albania
- Asian: Philippine, Bangladeshi, China, and Sri Lanka (Ceylon)
- North-African/Middle east: Morocco, Egyptian, Algeria, Tunisia, Iraq and Lebanon
- Sub-Saharian: Ghana, Nigeria

Free gambling session:

After completing the first part of the experiment, participants were told they were free to gamble in the agency (they were free to gamble on any game with any amount of money). They had been told that, in principle, they could stay there without even betting. The only condition we imposed is that they had to collect and store all of their betting receipts (winning and losing). To do this, they receive a pouch in which to store all the tickets. They had been told that they would be stopped after a certain length of time, to complete the second part of the questionnaire. During the free gambling time, the researcher decided whether the subject had to be stopped after one or four hours by a coin toss. The different duration of the gambling session is our exogenous treatment (see Chapter 3). After the assigned time, the participant was stopped. The researcher took the tickets collected by the participant and stored them in an envelope with a number linked to the subject and his/her questionnaire. The tickets issued by the gambling agency contain various information on the bet and this allowed us to trace very precisely the subjects betting history. For our two analyses, in particular, we took into account the following ticket information:
- time of the bet
- type of game (virtual, horse races etc.)
- odds of the bet
- amount staked

Second part of the experiment

At the end of the free gambling session (1 or 4 hours), participants returned to the desk to complete the last part of the experiment. This second part was composed of a query on the perception of the expense, three behavioural tasks and a questionnaire to diagnose the level of gambling disorder (Diagnostic and Statistical Manual of Mental Disorder, fifth edition DSM-V). The first query concerned the perception that the gamblers had about their expenditure and balance. It asked the participants if they had planned a certain amount of money to bet before entering the agency, the amount of money they thought they had spent, and what perception they had about their balance (positive or negative).

Then, since slot machines and videolotteries do not issue receipts, another query examined the participants' history of this type of gaming via a self-reported questionnaire, which asked the amount of money spent, the amount lost and won, and the time spent on these machines.

After these questionnaires, the key behavioural traits (risk aversion in the gain and loss domain, and loss aversion) were re-tested. As in the previous part, we used the MPL method.

Gambling disorder measurement

The questionnaire ended with the measurement of the level of gambling disorder (as explained in Section 2). This was done using a self-reported questionnaire: the Diagnostic and Statistical Manual of Mental Disorder, 5th Edition (American Psychiatric Association, 2013). It is based on the criteria listed by the American Psychiatric Association and examines the relationship that the subjects have with the habit of gambling. It is composed of nine questions and allows us to discriminate between problem and non-problem gamblers (O'Brien, C., 2011). The DSM-V questionnaire was placed at the end of the experiment due to its possible emotional impact on the subjects. Personal questions about gambling could, in fact, influence the subject's behaviour.

Payment

At the end of the experiment the participants receive a fixed compensation of 20 Euro. In addition to that, one of the lotteries undertaken during the questionnaire, randomly drawn, was played for real, and rewarded according to the result. This is a common method in the literature (Cox et al., 2015).

The lottery prizes varied between zero and 300 Euro, with a mean expected value of 50 Euro. In this way, every decision might determine the amount of money that the participant could win, ensuring that each of them was perceived as real. There are, in fact, evidences supporting the vision under which in order to obtain a truthful measure of a given preference, it is essential that the decision that captures the given preference is perceived as real (Holt and Laury, 2002). In the literature it is still debated whether a behaviour differs when inspected under real or hypothetical incentives (Kuhberger, et al., 2002). Concerning risk preferences, some studies state that no significant behavioural difference was observed between real and hypothetical choices (Noussair, et al., 2013). Other studies, by contrast, indicate that behaviours are different in real or hypothetical situations (Slovic, P., 1969). Considering the context of our study, there were two justifications for the importance of a real remuneration. The first was that a different part of the brain circuity is activated when choices regarding real incentives rather than hypothetical ones (Camerer and Mobbs, 2017). The second motivation resides in the fact that money is one of the main motivators for gambling (Anselme and Robinson, 2013). Eliciting gamblers' risk preferences without winning/losing money could modify their behaviour. Since in the present study we are considering preferences regarding monetary decisions, the rewards issue was something extremely relevant for obtaining a truthful measure of them (for a recent review of elicitation methods see Charness, et al., 2016)

1.3.3 Subject Pool

The participants in the experiment were regular customers of a big gambling agency in Milan. The researcher invited every customer that entered the agency to participate in the experiment. The only discriminant used to select the subjects was that we informed them that the experiment could take up to five hours (although in reality 50% of them would be stopped after 1 hour and 50% after 4 hours). This led to selecting people who were used to long sessions of gambling in the agency. Since we were interested in this kind of gambler, this sample selection was allowed in our study.

Our sample was composed of 90 subjects; however, one of them did not answered the majority of the questions, and for this reason he was excluded from the analysis. We will focus now on the composition of the group of participants, analysing their socio-economic traits and their gambling habits.

- Socio-Economic Characteristics

Their socio-economic characteristics are shown in the table below.

Table 2: General Socio-Economic Characteristics

Socio-Economic variables	Value of the sample	Socio-Economic variables	Value of the sample
Age	50.7	Male	0.97
Italian	0.60	Single	0.48
Asian	0.20	Unemployed	0.10
North African - Middle East	0.17	Retired	0.23
Catholic	0.63	Muslim	0.16
Education	3.00	Income	2.00
	(Middle-Education)		(10000-20000 Euro)

Age is expressed in year.
Nationality, Religion, Gender, Single, Unemployed and Retired are expressed in percentage.
The values of *Education and Income* are the median of the sample.

Of the ninety participants in the experiment, the majority (60%) were Italian and the vast majority (97%) were male. Regarding religion, more than half (60%) were Catholic. The median *education* level was secondary school and the median *income* was between 10,000 and 20,000 Euro per year.

- Gambling Disorder Information

To divide our pool into problem and non-problem gamblers (habitual gamblers) we used the

DSM-V questionnaire, published by the American Psychiatric Association (APA) (see Section 2). As already explained, APA set as four the number of symptoms that are needed in order to consider a gambler as problematic. However, some researchers have suggested that the threshold for diagnosis should be reduced down to three, two, or even one criterion (Mitzner et al., 2011). The analysis was carried out using a dummy variable which is equal to 1 when the subject shows at least 4 symptoms (problematic under the definition given by the APA). We considered a symptom to exist if it had occurred at least once in the past year. In our pool, 62% were problematic gamblers according to the APA scoring method.

Table 3 shows information regarding the level of gambling disorder in our sample. The first column - number of symptoms -tells us how many symptoms had been experienced by the subject in the past year at least "once". The second column displays the number of subjects who had shown the specific number of symptoms. For example, the second row says that 6 subjects had shown only one of the 9 symptoms of gambling disorder at least once.

Table 3: Gambling Disorder Information

N. of Symptoms*	N. of Subjects**
0	4
1	6
2	11
3	13
4	10
5	15
6	10
7	7
8	8
9	5

**N. of Symptoms* indicates the number of symptoms experienced by the subject in the past year at least "once": 0 means that no symptoms are detected in the subject, 1 means that one symptom is detected in the subject, etc.

***N. of subjects* who have shown the specific number of symptoms in the past year at least once.

Table 4 shows information regarding the occurrence of each specific symptom inspected in the DSM-V.

The first column lists the DSM-V's items from 1 to 9 (a complete list of the items is given in Appendix 1). Columns 2, 3, 4, and 5 show the number of subjects who have said they have experienced the specific item with the following frequencies: never, once, sometimes, and often, respectively. For example, the first row says:

Concerning item 1, 39 subjects have answered "never", 10 subjects have answered "once", 25 subjects "sometimes", and 15 subjects have experienced the symptom "often".

Table 4: Gambling Disorder Information

DSM-V items	N. of subjects =never*	N. of subjects =once**	N. of subjects =sometimes***	N. of subjects =often****	sum
Item 1	39	10	25	15	89
Item 2	36	6	24	23	89
Item 3	44	9	19	17	89
Item 4	46	9	20	14	89
Item 5	56	4	20	9	89
Item 6	21	5	24	39	89
Item 7	34	14	25	16	89
Item 8	64	5	10	10	89
Item 9	61	9	17	2	89

**N. of subjects* who have answered that the item is occurred "never" in the past year.
***N. of subjects* who have answered that the item is occurred "once" in the past year.
****N. of subjects* who have answered that the item is occurred "sometimes" in the past year.
*****N. of subjects* who have answered that the item is occurred "often" in the past year.

- Behavioural Traits Information

Table 5 shows the mean values of the behavioural traits of our subject pool. These measures were obtained using the behavioural tasks set in the first questionnaire, before the subjects started to gamble. For a detailed explanation of the behavioural traits and the tasks used to measure them, see Chapter 1.2.

Table 5: General Behavioural Traits (Experiment Measurement)

Behavioural Traits	Mean	Value explication	
Risk Aversion - BRET	88 %	Risk averse subjects	
Risk Aversion - MPL (gain domain)	61 %	Risk averse subjects	
Risk Aversion - MPL (loss domain)	43 %	Risk averse subjects	
Loss Aversion - MPL	80 %	Loss averse subjects	
Prob. Weighting - MPL	32 %	Overweighting probability subjects	
Ambiguity Aversion - MPL	3.27	0= neutrality and	10= max aversion
Coin Toss Game			
Gambler's Fallacy	20%	subjects behaving as	gambler's fallacy
Rational	32%	subjects behaving as	rational
Continuation	14%	subjects behaving in	a continuation way
Rollercoaster	33%	subjects behaving in	rollercoaster way
Time Preferences - MPL Gain domain			
Interest rate (today-tomorrow)	2,428 %		
Interest rate (today-next month)	1,791 %		
Interest rate (tomorrow-next month)	1,798 %		
Time Preferences - MPL Loss domain			
Interest rate (today-tomorrow)	114 %		
Interest rate (today-next month)	208 %		
Interest rate (tomorrow-next month)	135 %		

Risk aversion - BRET

Bomb Risk Elicitation Test. Subjects have to draw balls from an urn containing 99 white balls and 1 black ball. They earn 1 Euro for each white ball drawn. If they draw the "bomb" (black ball), they lose everything. We can consider a subject who draws less than 50 balls to be risk averse. More precisely, the lower the number of drawn balls, the higher the level of risk aversion. As can be seen, our subject pool drew an average of 20.6 balls (out of 100). In this task they behaved, on average, as risk averse subjects. In the specific, 78 (88%) subjects choose to draw a number of balls lower than 50 (risk averse subjects), 10 (11%) subjects choose to draw a number of balls equal to 50 (risk neutral subjects), and only one (1%) subject chooses to draw a number of balls higher than 50 (risk seeker subject).

Risk aversion - MPL

Risk aversion levels are measured by finding the indifference point of a subject between a lottery and a certain level of earnings (or loss in the case of the loss domain[10]). In our case the lottery had an expected value of 25 Euro (50% win 50 Euro / 50% win nothing). This means that people who accepted a payment of less than 25 Euro rather than play the lottery can be considered risk averse. On the other hand, people who were not satisfied with 25 Euro and switched their choice from the lottery to the known payment at a higher value than 25 Euro can be considered risk seeking.

Regarding the risk aversion level of our subject pool in the gain domain, Table 5 shows us that 61% (54 subjects) of people accepted less than 25 Euro, identifying them as risk averse subjects. 39% of subjects, on the other hand, showed more risk-seeking behaviour. The average switching point was 22.8 Euro.

Different proportions were found when considering the loss domain (subjects chose to lose a certain amount rather than play a lottery with the probability that 50% would lose 50 Euro and 50% would lose nothing). Table 5 shows that, in fact, 43% (38 subjects) of people chose to lose with certainty more than the expected value of the lottery (-25 Euro), identifying them as risk averse subjects. 57% of subjects, on the other hand, showed more risk-seeking behaviour. The average switching point was -23.5 Euro.

[10]Since we could not induce a real loss for the participants, we adopted the following procedure to make participants experience a loss: before performing the task, participants were endowed with 50 Euro. Any loss was then deducted from this initial amount of money.

Loss aversion - MPL

To measure loss aversion we used a mixed lottery task. Subjects had to choose whether they wanted to play a lottery that implied the possibility of both a win (50% win 25 Euro) and a loss (50% lose 25 Euro), or choose a fixed amount to win/lose, from definitely earning 20 Euro to definitely losing 20 Euro[11] (see Chapter 1.2). If a subject chose a fixed value smaller than the lottery's expected value (zero Euro on average), it meant that the possibility of losing 25 Euro weighed more on him than the same possibility of winning 25 Euro. This led us to consider him a loss averse subject.[12]

Table 5 shows us that the majority of the subjects (80%, 71 subjects) in our pool were loss averse people, with the average switching point of the whole sample being -5.3 Euro.

Probability weighting - MPL

To test particpants' tendency to weight the probabilities we used a multiple prize list task. Subjects had to choose between a certain amount, 25 Euro, and a lottery with a large prize (300 Euro) but with low probabilities (increasing from 1% to 8%). Note that every lottery choice had an expected value smaller than the certain amount (from 3 Euro to 24 Euro). This meant that every subject that chose even one of the lotteries was over-weighting low probabilities[13].

In our sample, as can be seen in Table 5, 32% of people chose to play at least one of the lotteries, identifying them as subjects who overweight low probabilities[14]. Among these subjects we found the average switching point was at the lottery that had a 3% probability. This means that on average, these subjects preferred a lottery with an expected value of 9 Euro rather than a fixed amount of 25 Euro.

Ambiguity aversion - MPL

[11] As in the case of risk aversion measurement in the loss domain, since we could not cause them to lose actual money, before starting the task, we provided participants with an initial endowment. Any subsequent loss was then deducted from this amount.

[12] A certainty equivalent lower than the lottery's expected value could also indicate risk aversion. However, when this measure is inspected using a mixed lottery, it captures the existence of a kink in the value function. The existence of a kink in the value function tells us the magnitude of the loss aversion's parameter. Several behavioural studies have adopted this method and a more detailed description is given in Section 1.2. Finally, in Chapter 2 we assessed this possible problem by implementing a method for controlling whether the task expressed loss aversion more than risk aversion.

[13] Choosing the lottery with a lower expected value than the certain amount offered could also be driven by a risk seeking behaviour.

[14] Since the experiment inspected the sample's risk aversion level has found participants to be, on average, risk averse, we can attribute the behaviour expressed in this task mainly to an attraction to big payouts (300 Euro) or alternatively to being driven by an overestimation of the low probabilities of the lotteries. Further analysis is needed to confirm these results.

Ambiguity aversion is the tendency to avoid situations in which probabilities are unknown. In our study it is measured using a task inspired by Ellsberg's Experiment (see Chapter 1.2 for a detailed explanation). We translate this propensity using an index with a scale from -10 (highly ambiguity loving) to 10 (highly ambiguity averse). We can see from Table 5 that, over the whole sample, the average ambiguity index is 3.27, indicating that our subject pool was slightly ambiguity averse. In particular, 70 % of the sample is ambiguity averse, 1 % is ambiguity neutral, and 21 % is ambiguity lover.

Gambler's fallacy - Coin Toss Game

The Gambler's Fallacy is apparent when past outcomes influence the gambler's current decision. We tested for the presence of this distortion with a coin-toss game task (see Chapter 1.2 for a detailed explanation). This specific task allowed us to observe four different possible behaviours:
Gambler's Fallacy: Influenced by past outcomes. Gives more probability to the event which has occurred less frequently.
Rational: Not influenced by past outcomes. Stakes are always the same.
Continuation: Influenced by past outcomes. Gives more probability to the event which has occurred more frequently.
Rollercoaster: Not influenced by past outcomes. Stakes are random.
As we can see in Table 5, the majority of people seem not to be influenced by past outcomes (rollercoaster and rational total 65%). The two kinds of distortions, on the other hand, was observed in 35% of our sample.

Time preferences - MPL

Finally, we find in Table 5 the time preferences results. It indicates the mean levels of the interest/discount rates elicited for the three time horizons for the gain and loss domains respectively. As can be seen, overall the subjects were extremely impatient in the gain domain. Indeed, it is clear from the table that gains and losses were discounted to different extents. However, a deeper analysis of these traits will be presented in Chapter 2.

- Free Gambling Session Information

Lastly, Table 6 sums up the most relevant information about the free gambling session. The information relates to the gamblers' betting history, captured by collecting all the subjects' betting receipts (winning and losing tickets). Note that, half of participants are leaved to gambling for 1 hours and the other half is leaved gambling for 4 hours. Table 6 shows the average levels of the variables considering both the two groups taken together.

Table 6: Gambling Behaviour (free gambling session)

Betting Variables	Mean	Betting Variables	Mean
Money staked	58.3 Euro	Average Odds Bet	21.1
Net balance	-26.0 Euro	Hourly expenditure	29.1 Euro/hour
N. Tickets Bets	15.7	N. winning Tickets	1.5

On average, participants gambled 58.3 Euro each, and the average odds, weighted for the amount spent on each bet, were 21.1. The average balance was a net loss of 26 Euro. On average, the expenditure per hour was 29.1 Euro. Finally, in terms of the number of tickets involved in the gambling session, on average 1.5 tickets out of 15.7 were winning tickets.

Table 7 shows the type of players in our subject pool. To assign a category we inspected whether a gambler had spent more than 50% of his budget on a single type of game. If so, he/she fell into that category. Note that 86 subjects spent 50% or more of their budget on one specific game. Thus, we had only 3 hybrid gamblers. The second column shows the average expenditure that each subject spent on his category of game.

Table 7: Type of Game (free gambling session)

Type of player	Percentage of subjects	Game's expenditure	Expenditure per subject within its category (Euro)
Virtual Player	0.34	Virtual Exp.	35
Horse race Player	0.46	Horse Exp.	41
Sport Live Player	0.03	Sport live Exp.	84
Sport Player	0.06	Sport Exp	9
Vlt Player	0.08	Vlt Exp.	135

We can see that the agency is frequented mostly by horse race gamblers (46%) followed by virtual players (34%). This proportion also reflects the average expenditure by gambling type. We observed, in fact, a mean expenditure of 41 and 35 Euro, within each of the latter categories. The gamblers who spent least in their own category were sports players (9 Euro). A remarkable finding is that, even though VLT players were a minority (8% of the pool), they spent an average of 135 Euro gambling on slot machines and VLT's.

In this first part of the paper we described the literature, the design of our experiment and its subject pool. As already mentioned, these data were used to carry out two different analyses. In the next chapter we will present the first one: *Individual Characteristics and Gambling Disorder*.

2 Individual Characteristics and Gambling Disorder

2.1 Introduction

Several studies consider both socio-economic conditions and behavioural characteristics to be important predictors of gambling disorder (J. Pearce et al., 2008; P. Ghezzi et al., 2000; T. A. Garrett and R. S. Sobel,1999). However, it is not clear which of these two traits weighs more when speaking of gambling. In our study we analyse these two types of individual characteristics simultaneously using original data on a sample of real gamblers collected in a real environment. We divided our sample into two groups, according to their level of gambling disorder. The division led us to obtain a subsample composed of problem gamblers and a second subsample composed of non-problem gamblers. By comparing these two groups, we aim to contribute to our understanding of the correlation between socio-economic characteristics, behavioural traits and the level of gambling addiction.

We hypothesised that behavioural traits play a significant role in explaining differences between problem gamblers and non-problem ones. In particular, we expected that problem gamblers would show higher levels of loss tolerance and risk tolerance. Our hypotheses are based on the Prospect Theory framework, according to which more than one mechanism could explain the excessive risk that gamblers are normally used to taking.

Our first expectation was about loss tolerance, hypothesising that problem gamblers are more loss tolerant than non-problem ones. This implies that the value function of problem gamblers is steeper for gains than for losses, and that this pattern is more pronounced for problem gamblers than for non-problem ones. This prevision is driven by the fact that losses are regularly experienced more often than gains during gambling. This, over time, could produce an insensitivity towards losses, raising the gamblers' level of loss tolerance (Ring, P., et al., 2018).

The second hypothesis claims that problem gamblers could be more risk tolerant than non-problem ones. This could be driven by the fact that they display a general upward shift in their risk preferences (Ligneul, R., 2013). Ligneul et al. call this phenomenon "probability elevation hypothesis" (Ligneul, R., 2013) and it expresses the gamblers' tendency to overweight (underweight) probabilities of gains (losses) over the whole probability range. These two traits (loss and risk tolerance) could, together or separately, characterise problem gamblers, hence explaining the "excessive" risk (in terms of probability and/or amount staked) that they are used to taking.

Moving on to the role played by gamblers' socio-economic characteristics, we expected that the more vulnerable subjects, in terms of socio-economic status, would be more prone to gambling disorder. This hypothesis is supported by several studies. Some find a positive correlation between living in a deprived area and the probability of participating in gambling (M. Griffiths et al., 2009); others claim that tension, frustration and marginalisation, which are conditions that often characterise low-status subjects, could be "alleviated" by the gambling activity (escape theory) (Gibbs Van Brunschot E., 2009).

In order to test our hypotheses, the first step was to determine how many gamblers in our pool, who were playing in the betting venue, are considered problematic. To achieve that, we used the criteria listed by the American Psychiatric Association, which designed the questionnaire DSM-V to classify gamblers' problematicity by inspecting the relationship that the gambler has with his gambling activity. The second step was the characterisation of the two groups (problematic and non-problematic) from two different perspectives: behavioural and socio-economic. Behavioural traits were measured using behavioural economics tools (as seen in the previous chapter), and socio-economic conditions were examined using a self-reported questionnaire.

Beside this main analysis, we answered a series of collateral research questions concerning self-control strategies. The starting hypothesis was that the habit of planning a set amount of money before starting gambling was a way to limit excessive expenditure on gambling. We tested whether this strategy was actually effective in limiting excessive losses, and whether it was adopted by the most healthy gamblers.

One of the peculiarities of this work is that, unlike most of the studies on this topic, which focus on one specific behavioural trait, this study produced an exhaustive analysis. In fact, it takes into account several economic preferences at the same time, mainly those regarding uncertainty, time preferences, probability distortion and cognitive distortions.
We now start to present more in detail our hypotheses, from both socio-economic and behavioural points of view. Then the results of the non-parametric analysis are presented. Finally conclusions and comments end the chapter.

2.2 Hypothesis on Socio-Economical Traits

A large branch of literature considers economic and social conditions to be potential determinants of gambling disorder (J. Pearce et al., 2008; P. Ghezzi et al., 2000). The literature seems to agree that there is a correlation between poor socio-economic conditions and high levels of gambling. In general people who live in a more deprived context are more likely to participate in gambling (M. Griffiths et al., 2009). The most relevant socio-economic factors that are correlated with the occurrence of gambling problems are social marginalisation, low status, poverty and being unemployed (M. Griffiths et al., 2009).

It is well documented, for example, that a higher density of gambling machines (slot machines and VLT) is observed in those areas characterised by the presence of more vulnerable people (in terms of income, education and age) (H. Wardle et al., 2014). However, it is still unclear if those individuals are more likely to participate in gambling activity because of their socio-economic condition or simply because gambling machines are more often located in those areas.

A different point of view is given by sociological and cultural studies. Some of these studies argue that gambling does relieve tensions and frustrations felt by individuals because of their position in society. Under this vision, gambling is used to escape from routine life in modern society (Gibbs Van Brunschot E., 2009). This could be one of the possible factors in the link between vulnerable people and gambling problems. In his book "The Racing Game", M. B. Scott sums up his observations on the subcultural world of racetrack betters: "the race track constitutes a little cosmos on its own. [...] Social class and other background characteristics of the players are excluded as irrelevant in this area." (M. B. Scott, 1968; p. 13). Therefore it may be that, for socially marginalised people, gambling venues are felt as a refuge where they can develop a more satisfying social life than that they have in the real world.

The above-mentioned literature tells us that one important indicators of gambling disorder is belonging to vulnerable categories. In accordance with this, we wanted to study whether members of minority ethnic groups, younger and older people, and low income and unemployed subjects displayed a higher rate of gambling disorders than citizens, medium age subjects and medium-high income subjects, respectively. For instance, the condition of non-citizen brings with it a series of other characteristics that could suggest a higher risk of pathology. For example, among some specific nationalities, gambling venues have become places for meeting compatriots. Moreover, in most cases immigrants are more vulnerable because they do not have previous experience of gambling and they have unrealistic beliefs about the probabilities of winning[15]. In addition to all of this, the literature suggests that language problems and limited knowledge could make it harder to access help.

The other important marginality is the age of gamblers. Young and adolescent are vulnerable categories that often are easily influenced (Rossen F., 2001; Froberg F., 2006). Some studies even underline that among younger people gambling is not viewed as a leisure activity, but rather as work (Binde P., 2008). When we consider older people the risk factors are different. They are, in fact, often lonely and with leisure time. There is evidence that these two conditions could raise the probability of becoming involved in gambling activity as a new form of recreation and entertainment (McNeilly, D. P., and Burke, W. J., 2001). A significant number of senior citizens, in fact, spend their leisure time in gambling venues (McNeilly, D. P., and Burke, W. J., 2001).

In the current study we want to confirm these hypotheses by correlating the rate of gambling disorder shown in a representative sample of actual gamblers with their income, their age, their education level and their nationality.

2.3 Hypothesis on Behavioural Traits

The present work bases its behavioural hypotheses on the framework offered by Prospect Theory (Kahneman and Tversky, 1979). This theory is based on two main ingredients: the asymmetric shape of the value function and the probability weighting function. The first tells us that humans evaluate losses and gains differently, and that, usually, losses hurt more than the same amount of gain makes people happy, in terms of utility. The second function tells us that humans tend to over-weight low probabilities and under-weight high probabilities when confronted with risky prospects. This nonlinear transformation of probability links objective and subjective probabilities, where subjective probabilities are deduced by observing the subject's choices (Tversky and Kahneman, 1992) (a more detailed view of the model is given in Section 1.2.1). Given this general knowledge, the main preferences to take into account when studying choices under uncertainty are mainly: *loss aversion*, *risk attitude* and *probability distortions.* All of these traits

[15]Some religious groups oppose all forms of gambling, for example Islam and Protestantism (Binde, P., 2007). Several countries have banned every form of gambling. These include: United Arab Emirates, Brunei, Cambodia, North Korea, Japan, Singapore, Cyprus, Qatar, Lebanon, Iran, Israel and Poland.

could contribute to explaining the problematic gamblers' tendency to take more risk than is usually taken by non-gamblers. However, in the literature on gamblers' behaviour we find many discordant results.

Several clinical and economical studies report that gamblers are more loss tolerant than non-gamblers (Gelskov, S. V., Madsen, K. H., Ramsy, T. Z., and Siebner, H. R. (2016).. Brevers, D., et al., 2012; Chib V. S., et al., 2012; Takahashi H., et al., 2013; B. De Martino et al., 2010). However, some recent findings raised some doubts about this evidence. For instance, Takeuchy et al. find that in an earlier analysis there was no significant difference, on average, in loss aversion rates between problematic and healthy subjects. Therefore the loss tolerance of problem gamblers appears to be similar to those of healthy people. However, a deeper analysis has shown that what seems to differ is the distribution of the loss aversion parameter in both groups. The loss aversion parameter appears to be uniformly distributed in the healthy group, in the problematic gamblers group, instead, the loss aversion distribution is biased towards the two extremes (low loss aversion, high loss aversion). According to this, problem gamblers can be divided into two categories: very loss-tolerant subjects and very loss-averse subjects (Takeuchi, H., et al., 2016). A second example is the work of Giorgetta et al., which finds that pathological gamblers were more loss averse, and using a mixed lottery task, they accepted a lower number of gambles with a positive expected value (Giorgetta, C., et al., 2014).

The present work wants firstly inspects loss aversion among gamblers. We hypothesise that gambling disorder correlates with a high level of loss tolerance. Support of this evidence is often found in neuroeconomics and clinical studies (B. De Martino et al., 2010). Moreover, this hypothesis can be explained by the fact that losses are regularly experienced by gamblers more often than gains during gambling, and this can lead gamblers to become less sensitive to losses. Their lower sensitivity to losses could be one of the explanations for the higher risk they are willing to take during gambling when compared with non-gamblers. In the context of problematic gambling we consider "higher risk" either higher odds betted and higher amount of money staked.

Within the Prospect Theory framework, a second factor plays a role in explaining the behaviour under uncertainty (as is the case in gambling). This factor is known as risk aversion. However, in the related literature we again find controversial results. Since gambling is an unfair game

the more intuitive assumption is that gamblers are risk-lovers. In this regard, some studies found risk-seeking behaviour among problematic gamblers (Ligneul R., et al., 2013). However, some other studies say that a diminishing sensitivity pattern has an important role in explaining risk-seeking behaviour (R. H. Thaler and E. J. Johnson, 1990). This implies that the level of risk aversion decreases as the amount of losses increase. Therefore, under this vision gamblers become risk-seeking after a certain amount of accrued losses. This effect is particularly evident in the presence of outcomes which offer a chance to break even: the break-even effect (R. H. Thaler and E. J. Johnson, 1990). Finally, some other studies seeking to explain risk-seeking say that gamblers are risk averse, but in cases where there is a low probability of winning (high payouts), they behave as risk-loving subjects because they are attracted by positive skewness (J. Grossman and C. Eckel, 2015). This last hypothesis, since gambling scenarios systematically involve a low probability of gains, has frequently been suggested as a possible explanation for the excessive attractiveness of gambling.
Given these previous results about risk attitude, the second objective of this work was to inspect risk attitude among gamblers. We hypothesised that the propensity of gamblers to take higher risks than non-gambler subjects could also be driven by a general upward shift in risk preferences (Ligneul et al., 2013; Ring, P., et al., 2018). This upward shift in risk preferences concerns the whole range of probabilities.

We aimed to give a comprehensive analysis of problem gamblers' risk attitude by studying separately the gain domain, the loss domain, and the problem gamblers' aversion to losses. Other studies have addressed these points, and there is still not a single account that explains gamblers' risk attitude. Moreover, we have to consider that the majority of experiments through which gambling is studied have some important flaws. For example, some authors have not used real money as rewards for lottery outcomes (as it is the case of Ligneul et al., 2013). In other cases, studies are focused only on non-gamblers (e.g. J. Grossman and C. Eckel, 2015; R. H. Thaler and E. J. Johnson, 1990). And some others, instead, have focused on a sample of pathological gamblers undergoing treatment (e.g. Gelskov, et al., 2016, Takeuchy et al., 2016; Giorgetta et al., 2014). However, gamblers who are recruited from treatment facilities often display less propensity for risk than non-treated ones. Hence, it seems possible that the treatment procedure affects the propensity for loss and risk aversion, partly offsetting the results of the experiment, if the objective was to determine the risk attitude of "active" gamblers. Finally, authors generally focus on only one behavioural trait per study. However, since more than one trait at the same time could drive the behaviour of a gambler, it could be useful to perform an experiment using different behavioural economics tools. The current work, using experimental procedures with incentivised tasks (real money), and analysing at the same time different behavioural traits seeks to obtain a general and comprehensive view of gamblers' behaviour.

2.4 Collateral Research Questions

Besides the main analysis, the study aims to inspect some other research questions. The first series of questions concerns the effectiveness of self-control strategies.

In particular, one of the most important self-control strategies adopted by gamblers is the habit of planning a set amount of money before starting to gamble. Help facilities and psychologists, for example, suggest adopting the habit of setting a monetary limit on gambling expenditure as a key strategy for promoting responsible gambling (M. Auer and M.D. Griffiths, 2013).

Although, in fact, most gamblers adopt the strategy of setting in advance a monetary limit on their play, many of them, in reality, do not respect it (A. E. Bergen et al., 2014).

This issue is the core of gambling disorder: both empirical evidence and theoretical models argue that the loss of control is one of the key factors in progressing from initial recreational gambling to persistent and uncontrolled gambling (A. Blaszczynski and L. Nower, 2002).

The first collateral research question asks how many gamblers, in our sample, used to adopt the strategy of fixing in advance a certain amount of money assigned to the gambling activity. To answer this question we used a specific item on the self-reported questionnaire.

After that we wanted to know if this type of strategy was effective: in other words, how many subjects who imposed an expenditure limit on themselves had respected it, at the end of the gambling session. Given the evidence shown by previous studies (A. E. Bergen et al., 2014; A. Blaszczynski and L. Nower, 2002) we expected to find that for the more addictive gamblers it was harder to respect the self-imposed limits. This lack of self-control could have two explanations. It could be, in fact, that gamblers consciously exceeded the expenditure limits because of their craving, or, instead, that they exceeded the limits because of a mistaken perception of the amount spent.

In order to discriminate between these two possibilities we included a specific question. It concerned their perception of the amount of money gambled and the amount of money won or lost during the free gambling session. Note that, with the gambling tickets collected during the free gambling session it was possible to check if their perception reflected the true amount[16]. A deeper understanding of the motivation that leads problematic gamblers not to respect self-imposed limits could be extremely useful in for developing effective prevention and treatment programs.

The second series of collateral research questions inspects the presence of cognitive distortion among gamblers. It is well known that cognitive distortions are some of the best predictors of gambling disorder (M. N. Potenza, 2014). Cognitive distortions are often caused by the use of *heuristics* in judgment. Heuristics is a particular approach to problem-solving that uses mental shortcuts to makes decisions. The use of mental shortcuts to take quick decisions often increases the onset of cognitive distortions.

Different types of cognitive distortions derive from the representativeness heuristic. In particular, the representativeness heuristic has been used to explain two opposite expectations which often occur when people face random sequences. Both happen when subjects consider the probability of a certain outcome on the base of previous outcomes, even if every event is statistically independent. The first distortion is named *gambler's fallacy*, and the idea is that even a very small sample of outcomes has to reflect the theoretical distribution of probability. After observing a given outcome, this fallacy makes us think that its probability decreases. Evidence of gambler's fallacy is found in the lottery environment: when a particular number appears among the winning numbers, the amount of money bet on that number falls (J. W. Lien and J. Yuan, 2015). Another evidence of gambler's fallacy is observed in the coin toss game: after four consecutive "tails", people estimate that the probability of obtaining "heads" is more than 50%, even though these events are statistically independent. The second type of distortion is called *hot hand fallacy*, and it leads to the opposite expectation. In fact, it leads people to think that after a sequence of a given outcome, it has to continue. Some authors argue that a hot hand fallacy happens more frequently when the sequence of outcomes reflects human performance; in contrast, when the sequence is driven by an inanimate mechanism then the gambler's fallacy is more frequently observed (Ayton, P and Fischer, I, 2004).

[16]Since VLTs do not issue tickets/receipts, the amount staked by VLT players was inspected via self-reported questionnaire.

The study of these distortions can also be useful in the analysis of gamblers' risk attitude because their presence can explain variation in a gambler's risk aversion during a session of gambling. In fact, in the presence of these types of distortions, risk aversion can be influenced by previous outcomes, since the estimation of probabilities now are based on past sequences. For instance, the existence of the gambler's fallacy could explain why risk aversion is thought to vary across time during a gambling session, meaning that, after a gambler has observed a given outcome more frequently then his risk aversion could rise since he believes that the probability of this outcome is lower than before.

In the current work this distortion was detected with the coin-toss task (see Chapter 1.2 for a detailed explanation). The results will tell us whether these distortions are higher in the most addicted people, and which type of distortion is more common among gamblers using a coin toss game.

The following sections present the results, starting with those regarding economic characteristics, then those from the experiments to investigate behavioural traits. Finally, the last section addresses the collateral research questions.

2.5 Results - Non-Parametric Analysis - Problem Gamblers vs Non Problem-Gamblers

2.5.1 Socio-Economic Traits and Gambling Disorder

We start by presenting socio-economic differences between problem gamblers and non-problem ones. From our sample, 55 of the participants met at least four of the DSM-V-TR criteria (American Psychiatric Association) (see Chapter 1.2) and therefore they can be classified as problem gamblers (62% of subjects in our pool). The remaining 34 participants can be classified as habitual (non-problem) gamblers (4 of them had not experienced any symptoms listed by the DSM-V).

Table 8 shows the average values or percentages of the socio-economic traits of problem and habitual gamblers (the traits are described in Chapter 1.2). In the last column of the table are shown the p-values of the significance test. Depending on the nature of the variable, p-values calculated using the Mann-Whitney or 2-sided Fisher's exact test are displayed. The null hypothesis of both tests is that the distribution of the given variable is equal between problem and habitual gamblers. Differences of 10% and below are considered statistically significant.

Table 8: Socio-Economic Differences among Problem and Habitual Gamblers

Socio Economic traits	Non-Prob. subjects (n.=34) Mean	Prob. subject (n.=56) Mean	P-value
Age (years)	55.4	48.2	0.039**
Employed (%)	0.59	0.74	0.166
Retired (%)	0.32	0.17	0.120
Single (%)	0.41	0.55	0.227
Income (categories)	2.28	1.88	0.063*
Education(categories)	3.09	2.96	0.353
Italian (%)	0.76	0.51	0.025**
Asian (%)	0.15	0.22	0.580
North African - Middle East (%)	0.06	0.24	0.040**
Muslim (%)	0.09	0.20	0.233
Catholic (%)	0.71	0.60	0.368

Observing the Mann Whitney (or Fisher) results, it can be seen that age, income level, and nationality play a significant role in explaining differences between problem and habitual gamblers. In confirmation of our hypothesis, younger people, subjects with lower income levels, and subjects who are not Italian citizens have a higher probability of falling within the problematic group. In particular, when comparing the non-problematic group to the problematic one, age falls significantly, from 55.4 to 48.2 (p=0.039); income falls from 2.28 to 1.88 (see income level chart, Chapter 1.3) (p=0.063); the percentage of Italian people goes down from 76% to 51% (p=0.025) while the percentage of North-African/Middle-Eastern subjects rises from 6% to 24% (p=0.040).

These results confirm the existence of marginality among problem gamblers. As expected, people in what we can consider to be vulnerable categories (young, poor and foreign people) are more likely to fall in the problem gamblers category.

2.5.2 Behavioural Traits and Gambling Disorder

In this section we inspect the differences in *behavioural traits* between problem and non-problem gamblers. In this first part we consider the behavioural traits measured by the experiment procedure and survey, using behavioural assessment tools.

As discussed in Chapter 1, the experiment's tasks required participants to make repeated decisions between binary monetary lotteries and different guaranteed monetary outcomes. These tasks allowed us to elicit risk preferences for gain-only, loss-only and mixed lotteries, allowing us to study risk attitudes in the gain and loss domains, and the degree of loss aversion. In addition, some other tasks elicited ambiguity preferences, time preferences, the presence of gambler's fallacy (or hot hand fallacy), and probability distortions over a small range of probabilities (1-9 %). These measures are compared across problem and non-problem gamblers by using the dummy variable that considers as a problem gambler anyone who has shown more than 4 symptoms in the DSM-V. We based our analysis on the framework offered by Prospect Theory. This theory allowed us to choose which behavioural traits were more relevant to predict gamblers' behaviour. However, the analysis does not strictly depend on this theory, but it is mainly based on a group comparison.

- Risk preferences elicitation

As explained in Chapter 1, generally the tasks that elicit risk preferences in the gain domain require subjects to start choosing a more attractive lottery over a low sure payment. As the sure payment gradually rises, it becomes more attractive than the lottery, until a certain point at which subjects switch and choose the sure payment. The switching point is generally very close to the certainty equivalent[17].

[17]The *certainty equivalent* is the point where the individual is indifferent between the sure payment an the

In the loss domain, in contrast, this behaviour is reversed. Indeed, subjects usually prefer losing a small and sure amount over the lottery. They generally switch to prefer the lottery when the sure loss increases. Since we could not make participants lose actual money, the potential losses were induced by endowing participants with an amount that could cover the largest possible loss.

In the mixed lottery task, subjects chose the loss (or gain) that made them indifferent between playing a 50/50 lottery with an expected value of 0 Euro and the sure loss (or gain).

Concerning risk preferences in the gain and loss domains, we calculated the normalised certainty equivalent following the method suggested by Vieider et al. and by Ring, P., et al. (Vieider, Chmura, et al., 2015; Vieider, Lefebvre, et al., 2015; Vieider, Truong, Martinsson, and Khanh, 2013, Ring, P., et al., 2018). This normalised measure implies that values below (above) the objective probability indicate risk aversion (risk seeking) in the gain domain. In the loss domain, this pattern is reversed.

Mathematically the normalisation can be formalised as follow:

The lottery L has 2 outcomes. We denote outcome x and y such that $|x| > |y| >= 0$

Under Prospect Theory framework, when x and y are both gains or both losses, the utility of lottery L can be calculated using the following specification:

$$U(L) = p * v(x) + [(1 - p) * v(y)]. \tag{2}$$

For simplicity, we assume a linear value function to calculate the normalised certainty equivalent. Given that, we take $v(x) = x$ and $v(y) = y$.

According to (2), the elicited certainty equivalent of lottery L is given by:

$$CE(L) = p * x + (1 - p) * y \tag{3}$$

We obtain a normalised certainty equivalent given by: $(CE(L) - y)/(x - y)$.

---

lottery

In the case of risk neutrality the normalised certainty equivalent is equal to p (which in our case is 0.5). In case of risk seeking the certainty equivalent is higher than the objective probability. And in the case of risk aversion, it is lower than the objective probability. In the loss domain, the pattern is reversed.

For mixed lotteries, we normalised the certainty equivalent by using a different values' range, which goes from 0 to 1. The point of loss neutrality would be indicated by a normalised certainty equivalent equal to 0.5; higher values indicate loss seeking, and smaller values indicate loss aversion.

The normalised certainty equivalents allow us to easily compare risk preferences elicited using Multiple Prize List method with the BRET method[18] (see Chapter 1 for a detailed description).

Finally, within risk attitude we have to look at the *probability weighting* propensity. Our task measures probability distortion only on a range of low probabilities (1% 8%). The elicited measures tell us the probability that makes subjects indifferent between taking a certain 25 Euro or taking 300 Euro with the elicited probability (see a more detailed explanation of the task in Section 1.2). In this task a subject who is not risk seeking, and is not inclined to probability distortion, should choose a lottery with a probability of at least 8% as only a probability higher than 0.08 gives an expected value higher than the certainty amount of 25 Euro. Every probability lower than 0.08 could either indicate that subjects are overweighting the small probability or that they are attracted by a big payout of 300 Euro.

We show in Table 9 the results of the Mann-Whitney test concerning these four behavioural traits, which are the main behavioural traits describing risk attitude. The null hypothesis is that the preference is equal between problem and non-problem gamblers. In addition, in the second and third columns are shown the mean values of each trait for problem and non-problem gamblers, respectively.

[18]BRET measures are rescaled by dividing the measures by 100.

Table 9: Differences in Risk Preferences among Gamblers

Risk Preferences	Non-Prob. subjects (n.=34) Mean	Prob.subjects (n.=55) Mean	P-values
Risk aversion BRET*	0.23	0.20	0.453
Risk aversion (gain)**	0.45	0.46	0.986
Risk aversion (loss)***	0.42	0.50	0.258
Loss aversion****	0.29	0.41	0.045**
Probability weighting*****	0.07	0.07	0.531

Differences of 10% and below are considered statistically significant.
Using the Bonferroni correction with only one significant p-value of 0.045, even testing only two hypotheses, the corrected p-value become no longer significant.
*BRET values are given dividing by 100 the number of balls drawn from the urn. Lower values than 0.5 indicate risk aversion. Higher values than 0.5 indicate risk seeking.
**Risk aversion values (gain domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk seeking, lower values than 0.5 indicate risk aversion.
***Risk aversion values (loss domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk aversion, lower values than 0.5 indicate risk seeking.
****Loss aversion values are given as normalised certainty equivalents. Higher values than 0.5 indicate loss seeking, lower values than 0.5 indicate loss aversion.
*****Probability weighting values indicate the probability that has made subjects indifferent between sure 25 Euro and 300 Euro with the elicited probability.

The BRET variable indicates the number of balls that subjects decided to draw from the urn (see a detailed description in Section 1.2). We used a values' range which goes from 0 to 1 in order to make it directly comparable with the measure of risk aversion detected by using the multiple prize list method. Note that a value equal to 0.5 indicates risk neutrality, a value lower than 0.5 indicates risk aversion, and higher values indicate risk seeking (as in the case of risk aversion via MPL). We can see that both of the groups can be classified as risk averse, with no significant difference between the two. Moreover, the mean values in both of the groups are very low, meaning that our sample is extremely risk averse when the trait is detected by the BRET task (only 1 subject can be classified as a risk seeker with a value higher than 0.5).

When we look at the risk aversion in the gain domain elicited by the MPL task we still observe no differences between problem and non-problem gamblers, and still overall the sample is risk averse, but in this case the values are very close to risk neutrality (normalised certainty equivalents equal to 0.45 and 0.46). Moreover, 35 subjects can be classified as risk seekers, with a normalised certainty equivalent higher than 0.5.

Concerning risk aversion elicited in the gain domain, one important point comes up: irrespective of the division between problem and non-problem gamblers, we noticed that there was a significant difference in the risk levels elicited with the two methods: the MPL and BRET tasks (Wilcoxon test p-value lower than 0.0001). In fact, the BRET task showed that all the subjects are quite strongly risk averse (values around 0.2). When switching to the MPL method (risk aversion in gain domain) we found values around neutrality. Also, when converting the values of the MPL and BRET tasks of the whole sample into a *risk aversion parameter* (α) assuming an exponential utility function, we found that the two measurements were significantly different (median value of α_{MPL}= 0.87; median value of α_{BRET}= 0.75; Wilcoxon p=0.0002). A possible interpretation of this discrepancy is that since the BRET task has no safe options (see Chapter 1.2) it is experienced more like real gambling, even in very risk averse choices. On the other hand, since in MPL risk averse choices are actually safe options, this does not permit a very risk averse gambler to play at all, thus inducing gamblers to behave more risk tolerantly than they normally would in a real gambling moment.

In the case of risk aversion in the loss domain, the normalised certainty equivalents are reversed. Therefore, from Table 9 we observe that in case of losses the non-problem group is risk seeking, with an mean value of 0.42. The problem gamblers group is, instead, risk neutral. However no significant differences between the two groups is detected. Overall, 51 (57 %) subjects are risk seeking in the loss domain with a value lower than 0.5; between these subjects, 22 are non-problem gamblers and 29 fall into the problematic group.
According to our expectation, we observe significant difference in the risk propensity of our sample between the loss and the gain domain. Subjects are, in fact, risk averse in the gain domain and risk seeker in the loss domain with a Wilcoxon test p-value of 0.0736 [19].

When we look at the level of loss aversion, we detect a significant difference between the two groups. Overall, the sample is, on average, loss averse; 71 subjects were, in fact, averse towards losses with a value lower than 0.5. However, non-problem gamblers were significantly more loss averse than problem ones (0.29 vs 0.41, p-value=0.045). According to this result, it seems that our hypothesis on loss aversion is confirmed. We actually expected that problem gamblers would have a higher tolerance of loss than non-problem ones. Our expectation came from the fact that typically in a gambling context losses are experienced by gamblers more frequently than gains, and this could lead gamblers to become less sensitive to losses. However, as noted in Chapter 1.2, choices taken in the mixed lottery task could also be driven by risk aversion as well as loss aversion. For this reason in the next section we will purge the effect of risk aversion from loss aversion.

[19]Using the division between problem and non-problem gamblers the difference is no longer significant.

Finally, Table 9 shows the inclination to distort small probabilities. As we can see, both of the groups chose, on average, a lottery with a probability of 7%, with no significant difference between the two. A non probability-distorted behaviour should be indicated by a elicited probability higher than 8% (giving an expected value of more than 25 Euro). According to this, overall, there is no strong evidence of probability distortion. A more informative view can be given by noting that 55 subjects chose a probability higher than 0.09 (either no risk seeking or no probability distortion behaviour). In contrast, 26 subjects chose a probability lower than 0.06, and in particular 9 of them have overweighted probabilities by choosing the lottery which gave 300 Euro with a probability of 1%.

Loss Aversion Elicitation

In this section we want to inspect whether our mixed lottery task captures loss aversion more than risk aversion. We begin by emphasising that we designed the task by following both the definition of loss aversion given by Kahneman and Tvesrky [20], and the method usually adopted in the related literature. For instance, many studies use this type of prospect (mixed lotteries) to inspect loss aversion (Gelskov, S. V., et al., 2016; Ring, P., et al., 2018; Giorgetta, C., 2014). Indeed, a mixed lottery task allows us to inspect the existence of a kink in the value function. A kink in the value function makes the value function's steepness in the loss domain different from its steepness in the gain domain (which is expressed by the loss aversion parameter λ in the model suggested by Tversky and Kahneman, 1992). However, some doubts can arise as to whether risk propensity may play a role in determining this type of decision. We cannot be sure, in fact, whether a person chooses the status quo (win 0 and lose 0) instead of playing the lottery (with an expected value of zero) because he/she is loss averse or because he/she is risk averse. In order to shed light on this, we implemented the following procedure:

- Step 1: to calculate the individual risk aversion parameters in the gain and loss domains separately. This was achieved by using measurements from the MPL tasks (those related to the gain domain only and to the loss domain only - see Section 1.2). In order to calculate individuals' values for these two parameters we adopted the common power value function as suggested by Tversky and Kahneman (1992). In addiction, in this first step we assumed the λ parameter to

[20]Kahneman and Tvesrky state that an individual is loss averse if she or he dislikes symmetric 50-50 bets, Kahneman and Tversky, 1979, p.279

be equal to 1, implying that we assumed subjects were loss neutral. If we assume λ equals 1, then the only two parameters that gives the shape of the value function are α and β[21]. The model is presented in Section 1.2.1.

In the gain domain subjects had to choose between taking a sure amount (increasing amounts from 5 Euro to 45 Euro) or playing a lottery which gave 50 Euro with 50% probability or 0 Euro with 50% probability. Therefore, α coefficient can be calculated by using the following expression:

$$U(ce) = \frac{1}{2}U(50) + \frac{1}{2}U(0) \tag{4}$$

Where ce is the elicited certainty equivalent.

Since in the gain domain the utility function is given by $U(x) = x^{\alpha}$, expression (4) takes the following form:

$$(ce)^{\alpha} = \frac{1}{2}(50)^{\alpha} + \frac{1}{2}(0)^{\alpha} \tag{5}$$

For the loss domain the procedure was the same as for the gain domain. Participants had to choose between losing a sure amount (decreasing amounts from -45 Euro to -5 Euro) or playing a lottery which gave a loss of 50 Euro with 50% probability or a loss of 0 Euro with 50% probability Therefore, β coefficient can be calculated by using the following expression:

$$U(-ce) = \frac{1}{2}U(-50) + \frac{1}{2}U(0) \tag{6}$$

Where ce is the elicited certainty equivalent.

Since in the loss domain the utility function is given by $U(x) = -\lambda(-x^{\beta})$ for $x < 0$, expression (6) takes the following form:

$$-\lambda(ce)^{\beta} = \frac{1}{2}(-\lambda(50)^{\beta}) + \frac{1}{2}(0)^{\alpha} \tag{7}$$

[21]Since we are calculating a power function's coefficients, extreme preferences (e.g to prefer losing more than 45 Euro for sure rather than playing a lottery which gives 0 Euro with a probability of 50% and a loss of 50 Euro with a probability of 50%) lead to exaggerated coefficients (β >13). In order to avoid exaggerated coefficients, we have limited these extreme preferences to the highest (lowest) possible certain amount offered. This means that, for example, if a subject chooses always to lose the certain amount then the certainty equivalent is fixed at 45 Euro (instead of 47.5 Euro). The same procedure was followed for certainty equivalents in the gain domain.

From (5) and (7) assuming λ=1 and given the certainty equivalent elicited using MPL tasks, we calculated for each participant both α and β.

Table 10 shows the median of the α parameter (risk aversion in the gain domain) and the median of the β parameter (risk aversion in the loss domain), for problem and non-problem gamblers respectively. In addition, in the last column are reported p-values from Pearsons chi-squared test [22] to assess significant differences between the two groups. The null hypothesis is that the samples were drawn from populations with the same median.

Using the median values, p-values indicate that only risk aversion in the gain domain is significantly different between problem and non-problem gamblers [23]. Both groups are risk averse in the gain domain, but the problematic group is significantly more risk averse with respect the other group. In the loss domain the two groups shown the same level of risk aversion (in median), which is very close to neutrality.

Table 10: Risk Aversion Parameters: Differences among Problem Gamblers

Risk Aversion	Non-Prob. subjects (n.=34) Median	Prob.subjects (n.=55) Median	P-values
α parameter*	0.87	0.66	0.003**
β parameter**	0.87	0.87	0.791

Differences of 10% and below are considered statistically significant.
*α parameter's values indicates the individual risk aversion in the gain domain (higher values than 1 indicates risk seeking).
**β parameter's values indicates the individual risk aversion in the loss domain (higher values than 1 indicates risk aversion).

- Step 2: We calculate which should be the optimal choice in the mixed lottery task giving the individual risk aversion in the gain (α) and in the loss domain (β) and by assuming loss neutrality ($\lambda = 1$).

In the mixed lottery task the participant has to choose between a certain loss or gain (values are increasing amounts from -20 Euro to +20 Euro) and a lottery which gives 25 Euro with 50% probability and a loss of 25 Euro with 50% probability.

Using the power value function as shown in (5) and (7), we can calculate the optimal certainty equivalent given α and β of the previous step.

[22] K-sample equality of medians test (continuity corrected).

[23] Using the Mann-Whitney test α and β parameters are equal between problem and non-problem gamblers.

If the certainty equivalent falls in the gain domain then we use the expression given by:

$$(ce)^{\alpha} = \frac{1}{2}(+25)^{\alpha} + \frac{1}{2}(-\lambda(25)^{\beta}) \tag{8}$$

If the certainty equivalent falls in the loss domain then the expression is given by:

$$-\lambda(ce)^{\beta} = \frac{1}{2}(+25)^{\alpha} + \frac{1}{2}(-\lambda(25)^{\beta}) \tag{9}$$

Since we are inspecting the optimal choice (certainty equivalent) given α and β when the subject is loss neutral, λ is equal to 1.

In Table 11 are reported the mean values of the optimal choice (certainty equivalent calculated in (8) or (9), and the mean value of the difference between the optimal choice and the actual choice elicited in the mixed lottery task. Note that a greater difference between the optimal and the actual choice means that loss aversion is playing a bigger role in explaining preference in the mixed lottery task than where the differences are smaller. Little difference indicates, instead, that the choice expressed in the task was mainly driven by risk aversion more than loss aversion (or λ is actually close to 1, meaning that subjects are actually loss neutral).

Table 11: Optimal Choice vs Actual Choice in Mixed Lottery Task - Differences among Gamblers

	Whole sample (n.=89)	Non-Prob. subjects (n.=34)	Prob.subjects (n.=55)	P-value
	Mean	Mean	Mean	
Optimal choice*	-0.6	2.1	-2.2	0.061*
Actual choice**	-5.3	-8.5	-3.2	0.045**
Diff. optimal actual	-4.7	-10.6	-1.1	0.009**
P-values*** Wilcoxon	0.005**	<0.0001***	0.572	

Differences of 10% and below are considered statistically significant.
*Optimal choice's values indicate the choice that the subject should have taken given the risk aversion shown in the MPL tasks (assuming loss neutrality).
**Actual choice's values indicate the choice that the subject has actually taken in the mixed lottery task.
***P-values of the Wilcoxon test are calculated by testing whether differences between the optimal and the actual choices are statistically significant.

Starting by observing the values for optimal choice in Table 11, we can see that, overall, the participants, given their risk propensity (α and β), should behave as risk averse in the mixed lottery task (choosing a certainty equivalent=-0.6, which is lower than the lottery's expected value= 0 Euro). However, this trend is driven by the risk aversion level of the problem group (optimal choice=-2.2, significantly different from that of the non-problem group (optimal choice=2.1), with a Mann-Whitney's p-value=0.061). The actual choice tells us what they actually did in the mixed lottery task. Overall, the sample chose an even lower certainty equivalent (-5.3 Euro<-0.6 Euro). However, the problem group chose a value close to that of the optimal choice (no significant difference between optimal and actual choice: Wilcoxon test p-value=0.572). This means that either their decision was mainly driven by their risk propensity or that they were close to loss neutrality (λ close to 1). In the case of the non-problem group, instead, we observe an opposite pattern. According to their risk aversion level (optimal choice) they should have chosen a certainty equivalent higher than the lottery's expected value (optimal choice=2.1). However, their actual choice was -8.5 Euro, lower than the optimal choice value. The non-problem group behaved as loss averse, and since risk aversion was not driving their behaviour, this could only be driven by loss aversion (λ).

This last evidence brings a proof that a mixed lottery task is able to capture loss aversion more than risk aversion. According to these results, problem gamblers are quite loss neutral. Non-problem gamblers, on the other hand, are significantly more loss averse than the problem group (Mann-Whitney; p-value=0.045) [24].

[24]In support of the loss aversion hypothesis, we want to underline that the proportions of risk averse subjects in the gain and in the loss condition are 61% and 43%, respectively. When we move on the mixed condition the proportion of risk averse subjects rises to 80%.

- Ambiguity aversion elicitation

In Table 12, we proceed by presenting our results on ambiguity aversion.

In order to capture this trait, we used a task inspired to Ellsberg's experiment (see Section 1.2 for a more detailed explanation of the task). Measures of ambiguity preference are given using an index which ranges from -10 to 10. A score of -10 indicates a subject who is an ambiguity lover while a subject who has a total aversion to ambiguous situations has a score of 10. The results of the experiment tell us that both non-problem and problem gamblers show a slight aversion to ambiguity, with no significant difference between the two (3.44 and 3.04, respectively). A more informative view can be given by noting that, considering the whole sample, 19 subjects have a value lower than 0, and hence can be classified as ambiguity lovers. The 8 subjects with an index of 0 can be classified as ambiguity neutral.

Table 12: Ambiguity Aversion Differences among Gamblers

Behavioural trait	Non-Prob. subjects (n.=34) Mean	Prob.subjects (n.=55) Mean	P-values
Ambiguity aversion*	3.44	3.04	0.567

Differences of 10% and below are considered statistically significant.
*Ambiguity aversion's values are given using a index varying between -10 and 10, where -10 indicates maximum ambiguity loving and 10 indicates maximum ambiguity aversion.

- Gambler's Fallacy and Hot Hand Fallacy elicitation

Table 13 addresses the existence of erroneous expectations when subjects face sequences of risky events. In particular, we used a coin toss game in order to inspect the presence of the gambler's fallacy (negative recency) or hot hand fallacy (positive recency).

All of the variables (gambler's fallacy, hot hand fallacy, rational, and rollercoaster) are dummy variables which are equal to one when the subject displays the behaviour indicated by the variable name. As we can see, there are no significant differences between non-problem and problem groups (using the two-sided Fischer test).

Some authors suggest that hot hand fallacy is more frequent when the sequence of outcomes reflects human performance, whereas when the sequence is driven by an inanimate mechanism it is more likely that gambler's fallacy will be observed (Ayton and Fischer, 2004). According to this vision, since a coin toss game is not driven by human performance, we expect to find a higher rate of gambler's fallacy behaviours. Actually, irrespective of the division between problem and non-problem gamblers, the percentage of subjects that behaved as if motivated by gambler's fallacy is significantly higher than that of those who behaved in the hot hand fallacy way (one-sided Fischer test; p-value=0.041). Thus, supporting the hypothesis under which when the sequence of outcomes reflects inanimate mechanism negative recency is more often observed.

Table 13: Erroneous Expectations among Gamblers

Type of fallacy	Non-Prob. subjects (n.=34) Mean	Prob.subjects (n.=55) Mean	P-values
Coin toss task			
Gambler's fallacy*	0.18	0.22	0.788
Hot hand fallacy**	0.21	0.11	0.231
Rational***	0.38	0.27	0.349
Rollercoaster****	0.24	0.40	0.166

Differences of 10% and below are considered statistically significant.
* Gambler's fallacy is a dummy variable equal to 1 if the subject shows the distortion. The mean value indicates the percentage of subjects who have shown the distortion.
** Hot hand fallacy is a dummy variable equal to 1 if the subject shows the distortion. The mean value indicates the percentage of subjects who have shown the distortion.
*** Rational is a dummy variable equal to 1 if the subject behaves in a rational way. The mean value indicates the percentage of subjects who have behaved in a rational way.
**** Rollercoaster is a dummy variable equal to 1 if the subject has not behaved in any of the previous ways. The mean value indicates the percentage of subjects who have behaved in a rollercoaster way.

- Time preferences elicitation

After having inspected those behavioural traits which are considered relevant in the behavioural economics literature within the process of decision making under uncertainty, we devoted this section to presenting the results concerning gamblers' time preferences.

Time preferences are elicited by using six tasks. Each of them investigates the interest rates that subjects attached over three different time horizons - today-tomorrow, today-one month, and tomorrow-one month - in the gain and loss domains, respectively. (A more detailed explanation of the tasks is given in Section 1.2). These different delays help us to inspect whether gamblers evaluate gains and losses differently, whether they have a propensity for present bias and/or hyperbolic discounting, and whether there are possible differences between problem and non problem gamblers.

Table 14 tells us the mean values of interest rates for non-problem and problem gamblers, and the p-values of the significance test. In particular, the first column displays the time-horizons we are taking into account (first for the gain domain and then for the loss domain). The second and third columns show the mean of the interest rates for non-problem and problem gamblers, respectively. And in the last column is shown the p-value of the Mann-Whitney test used to address differences between the two groups. Differences of 10% and below are considered statistically significant.

Table 14: Time Preferences Differences among Gamblers

Time horizon inspected	Non-Prob. subjects (n.=34) Interest Rate Mean (%)	Prob.subjects (n.=55) Interest Rate Mean (%)	P-values Mann-Whitney test
Gain Domain			
Today-Tomorrow	2,188	2,571	0.040**
Today-Next Month	1,639	1,865	0.323
Tomorrow-Next Month	1,662	1,863	0.368
Loss Domain			
Today-Tomorrow	-151	229	0.152
Today-Next Month	20	328	0.118
Tomorrow-Next Month	-25	237	0.103

By studying Table 14, we can firstly observe that the only significant difference between the two groups is given by the interest rate related to a one-day delay (today-tomorrow). Problem gamblers are more impatient than non-problem ones when they are due to receive money in the very short term. All of the other interest rates can be considered equal between the two groups. Secondly, looking at Table 14 we can confirm the evidence from the existing literature, according to which gains and losses are discounted at different rates (irrespective of the delay applied). Indeed, using the Wilcoxon test to compare the same horizons' interest rates in the gain and loss domains, we find that all of the three delays are discounted in a significantly different way when we move from gains to losses (p-values[25] are all lower than 0.0001). Therefore, overall, subjects are extremely impatient in the gain domain, irrespective of the delay applied (the interest rates in the gain domain vary from 1,632% to 2,571%). When gamblers are due to receive money they become extremely impatient compared to when they have to give money back, and this trait holds for both problem and non-problem ones.

Finally, our results exclude the existence of present bias. In order to test for the presence of present bias, we had to compare the interest rate related to the horizon today-next month with that related to the horizon tomorrow-next month. In this way, it is possible to observe whether the fact of receiving/paying a given amount of money is valued significantly differently depending on whether the delay starts today or tomorrow. Indeed, given a horizon of one month, one day's difference should not influence the interest rates elicited if present-bias is absent. This comparison was done using the Wilcoxon test, and there were no significant p-values. Hence,we could not reject the null hypothesis in every cases analysed[26]. On the contrary, we can confirm the existence of quasi-hyperbolic discounting, which happens when subjects do not show the same interest/discount rate over time, but instead, the interest rate reduces as the delay increases. In our case, the interest rate significantly decreases when we move from the one day delay to the one month delay. This effect is statistically significant both in the gain and in the loss domains, and both considering the problem group and the non-problem one.

[25] P-values from the Wilcoxon test are not shown in Table 14

[26] The null hypothesis of the Wilcoxon test is that the subject has choose the same interest rate both in the horizon today-next month and in the horizon tomorrow-next month.

2.5.3 Self-Control Strategy and Gambling Disorder

In this section we investigate the effectiveness of self-control strategies in limiting gambling expenditure. This point was addressed in our analysis firstly by asking participants, after the free gambling session, the following questions:

- Did you plan a certain amount of money to spend before entering the agency? If yes, how much was it?
- How much money do you think you spent during this free gambling session?

Table 15 shows the results of our analysis comparing the non-problem/problem groups. In particular, the first variable "Plan the amount" is a dummy variable equal to one if the subject has planned a certain amount of money before starting gambling. The second variable, "Difference Plan/Perception", indicates the difference between the amount planned and the perceived amount staked. "Difference plan/bet" is the difference between the amount planned and the amount actually staked. Finally, "Difference perception/real" indicates the difference between the perceived and actual amount staked. The last column of the tables shows the p-values calculated using the Mann-Whitney or Fisher test respectively.

Table 15: Effectiveness of Self-control Strategy among Gamblers

Variables	Non-Prob. subjects (n.=34) Mean	Prob. subject (n.=55) Mean	P-values
Plan the amount (D)*	0.53	0.58	0.630
Difference Plan/Perception**	-17.1	-5.6	0.082*
Difference Plan/Bet***	-23.7	8.2	0.413
Difference Perception/Real****	-2.4	14.7	0.008**

Differences of 10% and below are considered statistically significant.
*Plan the amount (D) is a dummy variable equals to 1 if the participant has planned its budget of expenditure before starting to gamble.
**Difference Plan/Perception indicates the difference between the amount planned and the perceived amount actually spent. Values higher than 0 indicate that they think to have spent less than the amount planned.
***Difference Plan/Bet indicates the difference between the amount planned and the amount actually staked. Values higher than 0 indicate that they have spent less than the amount planned.
****Difference Perception/Real indicates the difference between the perceived and the actually amounts staked. Values higher than 0 indicate that they think to have spent more than the amount actually staked.

Firstly, the above results tell us that the habit of planning the amount of money before gambling is perfectly equally distributed between problem gamblers and non-problem ones. As we can see, around 50% of the subjects in both groups have the habit of planning their outlay.

Secondly, in respect of the perceived amount spent, both groups think they staked more than the planned amount. In particular, non-problem gamblers think they spent 17.1 Euro more than planned, and problem ones think they exceeded their limit by 5.6 Euro. This difference between the two groups is significant.
The variable "Difference plan/bet" tells us that the previous evidence is true for the non-problem subjects (the actual excess was 23.7 Euro), but it is not true for the problem gamblers. In fact, the amount they actually staked was in reality lower than the amount they planned (+8.2 Euro). It is clear that for problem cases there is a problem of perception of money staked. In order to investigate this point more thoroughly we turn our attention to "Difference perception/real". An interesting statistic comes up: problem gamblers thought they had spent more than they actually had. In fact, non-problem gamblers knew their actual gambling expenditure (on average the error is only 2.4 Euro), whereas problem gamblers overestimated the money they had actually staked by 14.7 Euro.

Notice that, due to the design of the experiment, participants are stopped in the free gambling session after 1 or 4 hours. However, after having completed the last part of the experiment, they may have continued to gamble. Since the planned amount of money refers to the whole gambling day, we cannot know at the end of the day if it was actually been respected or not. The only information we can consider is whether at the end of the experiment the amount planned had been spent to or not. In the case of problem gamblers, the gambling expenditure is lower than the planned amount. So, the money limit was respected within the end of the experiment. For non-problem gamblers, instead, we observe that they already exceeded their limit of 23.7 Euro at the end of the experiment (therefore, the limit will be actually exceeded also at the end of the day). However, we have to consider that the average amount imposed by problem gamblers (63.2 Euro) was higher than the average amount imposed by the non-problem group (48.6 Euro). Looking at our research question about how many of the gamblers who imposed on themselves a planned amount respected it, our findings are the opposite of our hypothesis. We assumed that it would be harder for problem gamblers to respect self-control limits. In reality they actually spent less than the amount planned, even though they thought they had spent more than planned[27].
The interesting information we can deduce from this evidence is that the loss of control which

[27] We cannot know if they had still kept to their limits by the end of the day

characterises problem gambling, may also results in a mistaken perception of gambling expenditure (the error is about 14.7 Euro, significantly different from the error committed by the non-problem group P-value=0.008).

2.5.4 Type of Game and Gambling Disorder

Since the type of game used by gamblers seems to play a significant role in predicting gambling disorder (T. Leino et al., 2014), a specific section is devoted to addressing this question. Different type of game have specific characteristics that can affect individuals behavioural traits in different ways (T. Leino et al., 2014). According to this view, gambling problems cannot be explained by considering only factors at the individual level: the distortions that characterise gambling behaviours are very much determined and induced by specific mechanisms that are direct consequences of the features of the games (R. T. Wood et al., 2004). These mechanisms work according to the principle of *reinforcement schedules*. The goal of reinforcement schedules is to increase the possibility that a specific behaviour will occur again in the future. In particular, schedules of reinforcement are sets of rules used to reinforce or to punish a specific operant behaviour [28]. Schedules of reinforcement are important components of the learning process through which a specific behaviour is associated with its consequences, and either maintained or modified depending on the type of consequences (R. I. F. Brown et al., 1986). In this regard, the work by Delfabbro (P. H. Delfabbro et al., 2011) underlines that the most addictive games are those characterised by high rapidity and repeated betting. Indeed, the rapidity and the repetition of specific actions are two important modalities through which reinforcement schedules work. This evidence is confirmed by the result obtained by M. Chliz in 2010 (M. Chliz, 2010). It examines the timing of rewards in a gambling context, focusing on the effect produced by immediate and delayed rewards (granted after 2 seconds and 10 seconds, respectively) on the number of bets played by the gambler. It is worthy of attention that with a 2s reward delay gamblers played on average 56 times, compared with only 38 when the reward delay was 10s (M. Chliz, 2010). According to this result, it would seem that the timing of the reward is able to induce more intense gambling activity. Further evidence is provided by an interesting study conduced in Norway in 2014 by T. Leino et al. They inspected the relationship between the structural characteristics of video lottery games and the gambling behaviour of the subjects. They examined to what extent excessive gambling behaviour could be explained by the game structure and to what extent by individual variables. This experiment was carried out in a natural setting and involved a very large sample of actual gamblers (users of video lottery games). However, since they did not test the individuals' level of gambling disorder, in their analysis there is no comparison between

[28] Operant behaviour refers to behaviour that "operates" on the environment producing consequences and is controllable by the individual

problematic gamblers at different levels of gambling addiction. The game features under consideration in their study were: payback percentage, hit frequency, size of wins, size of jackpot, and the complexity of game options. The result of their analysis shows that the number of bets made by a gambler is positively related to payback percentage, hit frequency and bonus options. In particular, when more options are available the number of bets increases. The more complex the game, the more attractive it is (T. Leino et al., 2014). On average, the model shows that in the explanation of gambling behaviours the structural characteristics of the game weigh more than demographic characteristics (T. Leino et al., 2014).

First of all, our analysis aims to show whether our sample tended to diversify the type of game used during the gambling activity, or instead tended to specialise in one specific/preferred game. Then, the analysis aims to shed light on whether specialisation or diversification correlates with problematicity. Finally, we inspect whether some games are significantly correlated to pathology. In the agency where our experiment took place, during a gambling session subjects can play five different games, all described in detail in Chapter 1.3.1: virtual games; horse races; sport games; live sports matches and VLT/slot machines.

The *Gini coefficient* helps us to answer the first question. It is a statistical measure of the distribution of a given variable among a group of subjects. The coefficient ranges from 0 to 1, with 0 representing perfect equality and 1 represents perfect inequality. Among our sample, Gini ranges from 0.433 to 0.800, with an average value of 0.753. This value indicates that our sample displayed a strong preference for specialising in one preferred game. There is, furthermore no significant difference between the Gini values of problematic and non-problematic gamblers. This means that specialisation in a game does not correlate with gambling disorders (The Mann-Whitney test shows a non-significant difference).

Table 16: Gini Index between Non-Problem and Problem Gamblers

	Non-Prob. Subjects Mean	Prob. subjects Mean	P-value
Gini index	0.763	0.747	0.283

The following non-parametric analysis (Table 17) shows whether there are correlations between the use of some specific games and the probability of being a problem gambler. This could tell us which type of game is linked to the occurrence of gambling disorder. In order to inspect this point we tested whether the distribution of the percentage of expenditure on a specific game[29] was significantly different between problem and non-problem gamblers.

Moreover, by following the classification by Bonnaire, C. et al. (2017), we divided the types of games into non-strategic gambles (virtual, or vlt), and strategic gambles (horse race, sport, or sport live). This division allows us to observe whether games involving skill (strategic games) are more frequently preferred by non-problem gamblers over pure gambling games (non-strategic games). We started with this hypothesis since non-strategic games are characterised by faster bets, which leads gamblers into automaticity. Fast bets and automaticity are both indicated by the relevant literature as possible features linked to a high degree of gambling disorder (P. H. Delfabbro et al., 2011; M. Chliz, 2010).

Table 17 shows the mean percentage of the participant's total expenditure spent on each type of game, splitting the sample into problem and non-problem gamblers. The last column shows p-values of the Kolmogorov-Smirnov test corrected for small sample size using the procedure suggested by Jan Vrbik (2018). This test allows us to assess significant differences in the distribution of the percentage of expenditure (for each type of game) between problem and non-problem gamblers.

Table 17: Problem and Non-Problem Gamblers across Different Games

Percentage of expenditure*	Non-Prob. Subjects Mean (%)	Prob. subjects mean (%)	P-values Kolmogorov-Smirnov
Strategic gambles			
Horse racing game	65.3	36.8	0.005**
Sport game	3.1	6.7	>0.999
Sport Live game	2.9	5.0	>0.999
Tot. strategic gambles	71.2	48.6	0.030**
Non-Strategic gambles			
Virtual game	26.4	40.6	0.089*
VLT game	2.3	10.8	0.890
Tot. non-strategic gambles	28.8	51.4	0.030**

* Percentage of expenditure indicates percentage of the participant's total expenditure spent on each type of game during the free gambling session. For example, 65.3% indicates that, on average, the non-problem group spent 65.3% of its budget betting on horse racing game.

First of all, Table 17 shows that the expenditure on strategic and non-strategic gambles is different among problem and non-problem gamblers. In particular, strategic gambles are significantly more frequently used by the non-problem group, which spent 71.2% of their budget on this type of game, with respect the problem group. This last group, in fact, devotes 48.6% of its budget to betting on this type of game. In contrast, the pattern is reversed when we look at non-strategic

[29] The variable *percentage of expenditure* indicates the percentage of the total gambling budget of each participant during the free gambling session which was spent on a specific game.

gambles. The percentage expenditure of problem gamblers on non-strategic games is significantly higher than that of non-problem gamblers (51.4% vs 28.8%, p-value=0.030). This supports our expectation that fast bets lead to higher automaticity, which correlates with a higher degree of gambling disorder, compared with games involving skill, which required a given amount of skill and time to be implemented.

Second, from Table 17 we notice that the large difference between types of game favoured by problem and non-problem gamblers comes from horse racing on one side, and virtual games on the other. The percentage of expenditure on horse racing bets, within the strategic games group, is significantly higher for non-problem gamblers than problem ones. In contrast, this last group has a higher significant expenditure on virtual games than the non-problem group.

2.6 Discussion

The experiment this analysis was based on took place in one of the largest betting agencies in Milan. This first point is one of the keys to understanding the value of this work, which aims to be, first of all, an exhaustive data collection in the world of gambling. The sample, in fact, includes a wide spectrum of gambler types. The agency is popular among people of all ages and nationalities. They gamble on a wide variety of games and sports, staking from few Euro to hundreds of Euro a day. We wanted to focus on people who actually spend a considerable part of their days gambling.

This is one of the few experiments in literature which combine the observation of a real gambling session with the measurement of behavioural traits using experimental tasks incentivised with real money.

We used this data to shed light on determinants of gambling disorder, using a vision that involves at the same time socio-economic and behavioural perspectives.

We found that more than 60% of our sample is classified as problem gamblers, according to the criteria listed by the American Psychiatric Association. This means that more than the half of the subjects that actually spend their time in the betting venue are gamblers that should be assisted by the help facilities.

This large subsample of problem gamblers differs from non-problem gamblers both in terms of socio-economic conditions and in terms of behavioural traits. In particular, problem gamblers are characterised by some relevant marginalities concerning their status. Younger people, non-Italian citizens and low income subjects are those more affected by this type of addiction.

The motivations seem to be several, and all reside in the weakness of these categories. Isolation, frustration, the wish to escape from everyday problems, lower capacity to manage probabilities and beliefs, and lower capacity to recognise dangerous activity are among the most important causes of gambling problems in such marginalities. What we have to take into account is that in most of the cases, problematic gambling could even aggravate the disadvantaged conditions of these categories. Addiction, losing a job, family breakdown, and bankruptcy are only a few of the consequences that may give rise to poverty and isolation among vulnerable subjects.

The second part focuses on gamblers' behavioural traits. It tells us that some individuals' behavioural traits also differ between problem and non-problem gamblers. However, contrary to our expectation this is not the case for risk propensity. We did not find, in fact, any significant difference concerning risk aversion levels between problem and non-problem gamblers, either in the gain domain or in the loss domain. What matters in distinguishing problem from non-problem gamblers, in terms of preferences, is their level of loss aversion. Problem gamblers are more loss tolerant, making them able to suffer greater losses than non-problem ones. This finding is in line with our expectation. Indeed, according to that, problem gamblers could be more loss tolerant because they typically experience losses more often than gains during gambling. And this makes gamblers less sensitive to losses. Within the Prospect Theory framework, this higher loss tolerance which characterises problem gamblers could be one explanation of the excessive risk taking observed in gambling addiction. These results come from a non-parametric group comparison that was based on normalised certainty equivalents, and therefore does not depend on a particular decision model.

The last piece of evidence this study provides in terms of the distinction between problem gamblers and non-problem ones concerns the type of game used. It found that the game used is linked to gambling disorder. Problem gamblers, in fact, spend a higher percentage of their budget on non-strategic games (VLT and virtual games) compared to gamblers with lower levels of problematicity. This last group, on the other hand, prefers to gamble on strategic games (horse racing and sport games) which typically involve higher amount of skill and time to play. We hypothesise that this could be driven by the fact that non-strategic games lead to higher automaticity, and therefore could be related to higher loss of control and gambling problems.

Other studies have analysed risk preferences among gamblers (Brevers et al., 2012; Gelskov et al., 2016; Giorgetta et al., 2014; Ligneul et al., 2013; Takeuchi et al., 2015; Ring, P., et al., 2018). In line with our findings, some of those found gamblers to be less loss averse than non-gamblers (Gelskov et al., 2016; Takeuchi et al., 2015). Some others, on the other hand, have found different results concerning loss propensity. For instance, Giorgetta et al. observed that problem gamblers were more loss averse than the control group, and the work of Ring, P., et al. tells us that no differences have been detected among gamblers related to this trait.

When we move to the results on risk taking behaviour, we cannot confirm the existence of the difference between problem and non-problem gamblers observed by Ring, P., et al. and by Ligneul et al. Both, in fact, report that problem gamblers are systematically more risk taking than non-problem ones.

Comparing these studies with the present one, we find some important differences. First, we investigated risk preferences for gain-only, loss-only and mixed prospects (in addition of other behavioural traits considered relevant in the gambling literature). The majority of existing studies (excluding that of Ring, P., et al., 2018) take into account a single aspect of risk propensity. Second, we used incentivised tasks in order to make gamblers' choices more comparable to the real world, whereas some of the studies mentioned used hypothetical incentives (Brevers et al., 2012; Ligneul et al., 2013; Takeuchi et al., 2015) to test gamblers' preferences. Finally, we tested our hypothesis on a sample of real gamblers in action. Other studies have restricted their findings to gamblers undergoing treatment. However, gamblers under treatment often display more accentuated risk aversion behaviour than that typically shown by gamblers in action.

At the same time we have to consider that our work has several limitations. Firstly, in order to focus on several traits, our analysis is based on one observations for each trait and for each participant. This led to making our analysis less reliable than other studies, which by focusing on one single preference could manage a larger number of observations per participant. Secondly, concerning risk preferences we used 50/50 gambles. However, gambling generally does not involve this type of probability. Finally, these results cannot tell us the causality of our findings. For example, it is unclear whether loss tolerance is the cause or the result of the addiction. We cannot say, in fact, whether problem gamblers, who experience losses more often, then become less sensitive to losses (less loss averse), or whether the problem ones have developed this addiction because of their lower sensitivity to losses. Only an investigation which observes gamblers' behaviour over time could give us a clearer view of the phenomenon. This will be the objective of the next chapter.

3 The Effect of Gambling

3.1 Introduction

The present work aims to investigate the possible causality between gambling addiction and behavioural traits. Several studies have proved the existence of significant differences in behavioural traits between pathological gamblers and healthy subjects (R. Ligneul et al., 2012; H. Takeuchi et al.,2016; Brevers et al., 2012; Gelskov et al., 2016; Giorgetta et al., 2014; Ring, P., et al., 2018; J. Grossman and C. Eckel, 2015). Indeed, the first part of this study (Chapter 2) confirms the existence of some of these differences. For instance, this was the case for the trait loss aversion. Using experimental tasks, we detected that before starting to gamble in the agency, the problem gamblers were less loss averse (values close to neutrality) than the non-problem ones. In contrast, regarding risk aversion, we did not find any significant difference in the levels of this trait between problem and non-problem gamblers. Overall, the analysis in Chapter 2 suggests that, within the Prospect Theory framework, the lower loss aversion which characterises problem gamblers could be one explanation for the excessive risk-taking observed in gambling addiction.

However, our results cannot explain the causality of our findings. It is unclear whether lower sensitivity to losses can be considered the cause or the result of the addiction. It could be the case that, because they experience losses more often, problem gamblers then become less sensitive to losses. Or it could be the case, instead, that problem gamblers have acquired this addiction because of their naturally lower sensitivity to losses.

The analysis we will describe in this chapter aims to clarify the direction of this causality. This point can be inspected by observing gamblers' loss aversion over time. To facilitate this, our experiment allowed us to look at the gamblers' behavioural traits (loss aversion and risk aversion) before and after a session of free gambling (see Chapter 1 for a more detailed explanation of the design of the experiment). In order to deal with endogeneity issues, we implemented an exogenous treatment by randomly allocating participants to gambling sessions with different lengths of time (a shorter or a longer session). We expected one of two different situations to come up: on one hand, if problem gamblers are more attracted to gambling because of their naturally lower loss aversion, then I expected that this trait would be stable over time, and a session of gambling would leave loss aversion unchanged. On the other hand, it could be the case that problem gamblers have become more tolerant to losses (compared with non-problem ones) because of their gambling activity. Indeed, the gambling activity implies experiencing losses by its very nature, and the longer the time spent gambling, the more the losses that the gambler experiences. This could have a desensitisation effect on the subject. If this mechanism is true of every person who gambles, the initial difference in loss tolerance found between the two groups as in Chapter 2 could be driven just by the greater number of losses typically experienced in compulsive gambling. In addition to this, the initial increase in a subject's loss tolerance due to gambling activity could trigger a vicious circle in which it is the augmented loss tolerance which leads the subject to continue gambling despite the losses. Since, in this case, the behavioural trait variation is attributed only to experiencing losses and is not related to individuals' characteristics, I would have expected the gambling activity to impact the loss tolerance level in all of the subjects participating in the experiment.

Regarding risk aversion, the analysis in Chapter 2 did not detect any significant difference between problem and non-problem gamblers, thus raising doubt about the effectiveness of this trait as a predictor of gambling disorder. However, our expectations were different. Indeed, the majority of the empirical studies of this argument state that gamblers are typically more risk-loving than non-gamblers (Ring, P., et al., 2018; Ligneul et al. 2012). This discrepancy could be driven by the fact that our study group is composed only of gamblers (we do not have a control group of non-gamblers).
A higher level of risk loving in gamblers subjects is in line with the Prospect Theory framework. In fact, gambling is an unfair game and a risk averse subject should not want to experience this type of game unless other motivations push them towards this activity. According to Prospect Theory, subjects are typically risk-seeking in the loss domain. In addition, the decreasing marginal utility leads subjects to feel more sharply losses which are closer to the status quo than losses further from the status quo. This implies that as losses accumulate, subjects should become more willing to take additional risk. In the light of this, we wanted to investigate whether gambling activity produces changes in risk aversion by measuring it before and after the gambling session. Since a longer time spent gambling should lead subjects to collect a higher amount of losses, we expected that a longer gambling session should increase the risk propensity of gamblers more than a short session. As in the case of loss aversion, since the possible variation in the behavioural trait is driven only by the gambling activity and is not related to personal characteristics, I would expect this mechanism to hold for the whole sample of gamblers.

We want to underline that due to the design of the experiment, which started and ended within the same day, we could only observe any possible variation in gamblers' preferences during a short period. This cannot exclude the possibility that if there is a temporary variation in a short period, it could settle down and become permanent over time. However, we cannot directly test this conjecture, and that is not the purpose of the present analysis.
To find a causal relation between gambling activity and variation in behavioural traits could be interesting for at least two reasons. Firstly, any increase in loss and/or risk tolerance could explain why gamblers continue to gamble despite losses. Secondly, any variation in a preference could explain the commonly-found time inconsistency between initial planned strategy and the gambler's actual behaviour. Indeed, gamblers typically end by taking more risk and spending more money than they planned (Andrade, E. B., and Iyer, G., 2008; Barberis, N., 2012).

The remaining part of this chapter proceeds as follow: we first focus on the experiment method and its validity, by inspecting the correct randomisation of our exogenous treatment. After having checked these two points, we present a non-parametric analysis to observe the variation in behavioural traits due to gambling. Then we move to a parametric analysis using a different specification to check the robustness of our findings. Finally, the analysis ends with the Arellano and Bond estimation to observe the gamblers' actual behaviour over the gambling session time.

3.2 Method

To inspect whether the activity of gambling causes changes in behavioural traits we need to compare individuals preferences over a gambling session time, by comparing their preferences with respect to different amounts of time spent gambling. We achieved this by using an exogenous treatment to ensure that other elements beyond the gambling activity did not impact the possible variation in behavioural traits. Therefore, we expected that no individual characteristics or endogeneity issues could explain a difference in behavioural traits other than a longer time spent gambling. According to our hypothesis, a longer session of gambling, which should imply experiencing higher losses, should impact subjects' loss aversion and subjects' risk aversion more than a shorter gambling session.

The gamblers were left to gamble freely in the agency for different amounts of time: half of them were stopped after one hour of gambling and the other half after four hours. Note that the participants did not know for how long they would be left playing before being stopped and asked to fill in the last questionnaire. In order to achieve exogeneity of the treatment, this selection was randomised by using a coin toss. Thus, we could test the individuals' most relevant preferences after a shorter and a longer session of gambling, observing whether a different time spent gambling affects these preferences differently. The behavioural traits measured after the gambling session were *risk propensity* in the gain and in the loss domain and *loss propensity.* All were elicited using the Multiple Prize List method. A more detailed explanation of the experiment design has been given in Chapter 1.3.

3.2.1 Intention to Treat

The main objective of the exogenous treatment was determine whether a longer session of gambling affects subjects' behavioural traits differently compared with a shorter session.
This different length of time is randomly allocated as 1 hour and 4 hours. However, this cannot ensure that gamblers were actually betting for the whole duration of the gambling session. Indeed, since during the gambling session they were betting with their own money, they could have stayed in the agency even without betting.
This issue is also known as the *intention to treat.* During the gambling session (either one or four hours), subjects should actually gamble for the whole time. Obviously it is not possible that all

of the subjects would have played for exactly the same time. However, people who deviated too much from the time of the treatment are not representative of a sample which gambled for one or four hours.

In order to examine the size/weight of this potential problem we considered the average time spent gambling for subjects in both groups. The average time spent gambling was calculated, for every subject, as the difference between the time of the last and the first bet (in minutes). Therefore, if a subject started to bet in the first minute of the gambling session and ended in the last minute of the session, then our indicator of the time spent gambling would be 60 minutes (1 hour treatment) or 240 minutes (4 hours treatment). This question is addressed in Table 18, in which for both of the treatments we display the number of subjects (second column), the average time spent gambling (third column), the standard deviation (fourth column), and finally in the last columns the minimum and maximum values of time spent gambling.
Notice that, since five subjects are exclusively VLT-players, we do not have their tickets, but only self-reported amounts of time spent gambling on VLT. We omitted these subjects from the statistics in Table 18.

Table 18: Average Time of Betting: 1 Hour vs 4 Hours

Time gambling (minutes)	No obs	Mean	St.Dev	Min	Max
1 hour Treat.	48	40	18	0	85
4 hours Treat.	36	121	48	0	209

Note, first, that we find two subjects who did not gamble at all, and one subject who, in contrast, gambled for 85 minutes even though he was in the one-hour treatment group. We decided to omit these three participants from the whole analysis in this chapter. The existence of maximum values higher than 60 minutes (only one was higher than 66 minutes) in the 1 hour treatment group is due to the fact that the researcher in some cases could not stop the participant precisely at the end of the gambling hour. In some cases the gamblers needed to finish gambling on a given race or finish watching a given race on the monitor.

A further indicator of the actual gambling activity is the *total amount spent* during the gambling session. This information is shown in Table 19. As before, number of subjects, mean values, standard deviation, and minimum and maximum values are reported.

Table 19: Average Money Staked: 1 Hour vs 4 Hours

Money staked (Euro)	No obs	Mean	St.Dev	Min	Max
1 hour Treat.	46	33	38	3	212
4 hours Treat.	36	73	83	5	311

In both cases (average time and average money), the Mann-Whitney test gives a p-value<0.001. Therefore, the time spent gambling and the amount of money staked is significantly different between the 1-hour group and the 4-hour group, meaning that our treatment was effective.

Moreover, since our expectation regarding variation in loss aversion was linked to exposure to losses, we further checked whether a longer session of gambling implied greater losses (and a higher number of losing tickets) compared to those who undertook a shorter session. Table 20 shows this information.

Table 20: Average Money and Tickets lost: 1 Hour vs 4 Hours

Money lost (Euro)	No obs	Mean	St.Dev	Min	Max
1 hour Treat.	46	-16	26	-96	37
4 hours Treat.	36	-39	50	-242	12
No. of losing tickets					
1 hour Treat.	46	11	12	2	76
4 hours Treat.	36	21	18	0	71

As we can see, a longer session of gambling implies more money lost and a higher number of losing tickets. These two results are tested using the Mann-Whitney test, which gives a p-value of 0.006 and of 0.004, respectively.

Finally, a further investigation that gave us interesting information regarding the *intention to treat* is the percentages of expenditure on different types of games within the two treatments groups. As we can see from Table 21, the only significant difference we detected in the percentage of expenditure between the 1 hour and the 4 hour treatment groups were related to sport live expenditure. On average, participants in the 1 hour group spent about 2% of their total budget on live sport games, whereas those of 4 hours group devoted 7% of their total expenditure to this type of game. And this difference is significant, with a p-value of 0.061.

Table 21: Percentage of Subjects by the Type of Game Used: 1 Hour vs 4 Hours

	Virtual Expenditure%	VLT Expenditure%	Horse racing Expenditure%	Sport-live Expenditure%	Sport Expenditure%
1 hour treat.	45	4	44	2	5
4 hour treat.	27	12	51	7	3
Mann-Whitney P-values	0.173	0.170	0.713	0.061*	0.890

3.2.2 Randomisation of the Treatment

For the *exogenous treatment* we split our sample into two groups: subjects who gambled for 1 hour and subjects who gambled for 4 hours. In order to make the treatment effective, this division had to be exogenous. This was achieved by allocating the participants to the groups using a coin toss. Correct randomisation implies that differences between the two groups should be randomly distributed. This section will analyse whether the sample characteristics were equally distributed among the subjects in the two different treatment groups.

Table 22 shows the socio-economic traits of subjects in the 1-hour and 4-hour treatment groups. The first column shows the names of the traits analysed. The second column shows the average levels of every given trait for subjects who gambled for 1 hour. The third column shows the average levels of the variables for subjects who gambled for 4 hours. Finally, the last column shows the p-values of the Mann-Whitney, two-side-Fisher test (depending on the nature of the variable).

Table 22: Socio-Economic Traits among Gamblers in 1 Hour and in 4 Hours Treatment Groups

Socio-economic traits	Treat. 1hour - n.47 Mean	Treat. 4 hours - n-39 Mean	P-values
Age (years)	50	53	0.427
Income (range 1/4)	2	2	0.787
Unemployed (% of subjects)	8	10	>0.999
Retired(% of subjects)	18	28	0.302
Education (range 1/5)	3	3	0.724
Single (% of subjects)	49	51	>0.999
Nationality			
Italian (% of subjects)	66	51	0.191
Asian (% of subjects)	15	26	0.279
North African - Middle East (% of subjects)	17	18	>0.999
Religion			
Catholic (% of subjects)	60	67	0.512
Muslim (% of subjects)	15	18	0.774

In Table 22 the p-values show that socio-economic traits are equally distributed among subjects in the 1-hour and 4-hour treatment groups, thus confirming a correct randomisation between the two groups.

Below we look at the distribution of behavioural traits. Table 23 displays the average values of the behavioural traits captured via experiment, comparing the two treatment groups (1 and 4 hours) by using the Mann-Whitney or Fischer test depending from the nature of the variable. The P-values shown in Table 23 suggest that traits are equally distributed among the two groups. Overall, tables 22 and 23 tell us that individuals' characteristics and behavioural traits are equally distributed among subjects belonging to the 1 and 4 hours treatment groups. Finally, we have to look at the most important aspect for the aim of our analysis: the distribution of the number of problem gamblers in the two groups. The distribution is perfectly equal. This is confirmed by finding that the percentage of problematic is 62% for treat-1hour and 64% for treat-4hours, with a Fisher test' p-value> 0.999).

Table 23: Behavioural Traits among Gamblers in the 1 Hour and 4 Hours Treatment Groups

Behavioral traits	Treat. 1 Hour -n.47 Mean	Treat. 4 Hours -n.39 Mean	P-values
Ricky preferences			
BRET	0.21	0.21	0.783
Risk Tolerance Gain (MPL)	0.49	0.41	0.139
Risk Tolerance Loss (MPL)	0.48	0.45	0.560
Loss Tolerance (MPL)	0.39	0.32	0.132
Ambiguity aversion (MPL)	3.8	2.6	0.486
Probability weighting (MPL)	6.7	6.9	0.827
Cognitive distortions	(coin toss task)		
Gambler's fallacy (% of subjects)	19	20	>0.999
Continuation (% of subjects)	21	8	0.129
Time preferences (MPL)	gain domain		
Interest rate today-tomorrow	2,463	2,419	0.558
Interest rate today-next month	1,816	1,777	0.877
Interest rate tomorrow-next month	1,789	1,819	0.938
Time preferences (MPL)	loss domain		
Interest rate today-tomorrow	-15	262	0.367
Interest rate today-next month	147	324	0.478
Interest rate tomorrow-next month	68	251	0.548

3.3 The Effect of Gambling - Non-Parametric Analysis

In this section we compare three relevant behavioural traits in our sample before and after the free gambling session. In the last part of the experiment we set our subjects three Multiple Prize List tasks to re-test some of their preferences regarding risk tolerance in the gain domain, risk tolerance in the loss domain and loss aversion. The objective was to see if a longer gambling session had a greater impact on them with respect that of a shorter session of gambling. This analysis was carried out using the Wilcoxon signed-rank test. The null hypothesis is that the level of the behavioural trait under consideration before gambling is equal to its value after gambling. We show results by focusing on risk aversion in the gain domain first, then on risk aversion in the loss domain, and finally, by inspecting possible changes in loss aversion levels.

3.3.1 Risk Aversion Variation

Starting from Prospect Theory framework and considering the definition of risk aversion, a risk averse subject should not gamble at all. For instance, evidence from several studies find gamblers to be more risk-loving subjects than non-gamblers, either in the gain or in the loss domain (R. Ligneul et al., 2012; Ring, P., et al., 2018). In the light of this, our hypothesis states that if gamblers have been attracted to gambling because of their natural risk propensity (to be risk lovers is the motivation for the attraction to gambling), then this trait should be stable, and the gambling activity should not affect this preference. On the other side, if risk propensity is not the motivation for gambling, then gambling could have modified this trait over time (leading gamblers to be more risk-loving subjects than non-gamblers). If this last hypothesis is true, we would expect to find that the more a subject gambles the more his risk aversion should decrease. In addition, we expected to find that this effect applied to our whole sample, irrespective of the division between problem and non-problem gamblers.

-Gain Domain

First of all, Table 24 shows us the levels of risk aversion for the gain domain, before and after the gambling session, irrespective of the lengths of the treatment. The first row displays the mean values for the whole sample (86 subjects); the other rows show the values considering non-problem and problem gamblers separately. Differences between the risk aversion levels before and after gambling are assessed by using the Wilcoxon test. P-values are shown in the last column.

Table 24: Risk Aversion Gain Domain Pre/Post Gambling

Risk Aversion values Gain domain	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.45	0.45	0.842
Non-Problem gamblers	0.44	0.45	0.909
Problem gamblers	0.46	0.45	0.755

Differences of 10% and below are considered statistically significant.
*Risk aversion values (gain domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk seeking, lower values than 0.5 indicate risk aversion.

Table 25 tells us the same information as Table 24, but considers only the participants who undertook the 1 hour treatment (short gambling session). As before, risk aversion values in the gain domain are shown considering the whole sample first, then considering non-problem gamblers, and lastly considering only the problem ones. Differences between risk aversion before gambling and risk aversion after 1 hour of gambling were assessed using the Wilcoxon test. P-valuse are shown in the last column.

Table 25: Risk Aversion Gain Domain Pre/Post 1 Hour Gambling

Risk Aversion values Gain domain	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.49	0.48	0.438
Non-Problem gamblers	0.43	0.44	0.927
Problem gamblers	0.52	0.50	0.377

Differences of 10% and below are considered statistically significant.
*Risk aversion values (gain domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk seeking, lower values than 0.5 indicate risk aversion.

Table 26 is organised similarly to Tables 24 and 25, showing information on risk aversion before and after 4 hours of gambling.

Table 26: Risk Aversion Gain Domain Pre/Post 4 Hour Gambling

Risk Aversion values Gain domain	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.41	0.43	0.662
Non-Problem gamblers	0.45	0.46	0.874
Problem gamblers	0.38	0.41	0.703

Differences of 10% and below are considered statistically significant.
*Risk aversion values (gain domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk seeking, lower values than 0.5 indicate risk aversion.

As we can see, there are no significant differences in the risk aversion level before and after the gambling session in any of the categories. And this evidence holds both when considering participants in the 1 hour treatment group and when considering those in the 4 hours treatment group. According to this result, neither a long session nor a short session of gambling is able to produce risk aversion changes in the gain domain.

Lastly, concerning risk aversion in the gain domain, Table 27 shows the variation in risk aversion between the 1-hour treatment and the 4-hour treatment. This variation was obtained as the difference between the risk aversion level after gambling and the risk aversion level before gambling. The significant differences were assessed using the Mann-Whitney test, under which the null hypothesis was that the distribution of the variation in risk tolerance was the same in both the 1 hour treatment and the 4 hours treatment. As we can see, there are no significant differences between the variation in risk aversion between a shorter and a longer session of gambling. This holds both when considering the whole sample and when considering the division between problem and non-problem gamblers.

Table 27: Risk Tolerance Variations Gain Domain - 1 Hour treat. vs 4 Hours Treat -

Risk tolerance variation* gain domain	Mean Treat=1	Mean Treat=4	P value Mann-Whitney
Whole sample	-0.01	+0.02	0.364
Non-Problem gamblers	+0.02	+0.01	0.771
Problem gamblers	-0.03	+0.03	0.313

Differences of 10% and below are considered statistically significant.
*Risk tolerance variation is the difference between the risk aversion value after gambling minus the risk aversion value before gambling. This difference can be in a range between -1 and +1. In the gain domain this means that higher values than 0 indicate that the risk aversion after gambling is decreased (subjects have become more risk tolerant). On the contrary, lower values than 0 indicate that after gambling the risk aversion is increased (subjects have become less risk tolerant).

-Loss Domain

Tables 28, 29, and 30 show us the risk aversion values considering the loss domain. As in the case of risk aversion in the gain domain, Table 28 shows risk aversion levels before and after the gambling session, irrespective of the length of the treatment. The first row displays values considering the whole sample (86 subjects); the other rows show results split by the two different gamblers groups.

Differences between the risk aversion levels before and after gambling were assessed by using the Wilcoxon signed-rank test. P-values are shown in the last column.

Tables 29 and 30 tell us the risk aversion values in the loss domain before for participants belonging to the 1 hour treatment group and then for the ones in the 4 hour treatment group.

Table 28: Risk Aversion Loss Domain Pre/Post Gambling

Risk Aversion values Loss domain	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.47	0.46	0.617
Non-Problem gamblers	0.42	0.40	0.692
Problem gamblers	0.50	0.50	0.766

Differences of 10% and below are considered statistically significant.
*Risk aversion values (loss domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk aversion, lower values than 0.5 indicate risk seeking.

Table 29: Risk Aversion Loss Domain Pre/Post 1 Hour Gambling

Risk Aversion values Loss domain	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.48	0.49	0.953
Non-Problem gamblers	0.47	0.42	0.303
Problem gamblers	0.49	0.54	0.474

Differences of 10% and below are considered statistically significant.
*Risk aversion values (loss domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk aversion, lower values than 0.5 indicate risk seeking.

Table 30: Risk Aversion Loss Domain Pre/Post 4 Hour Gambling

Risk Aversion values Loss domain	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.45	0.42	0.380
Non-Problem gamblers	0.36	0.38	0.449
Problem gamblers	0.51	0.45	0.180

Differences of 10% and below are considered statistically significant.
*Risk aversion values (loss domain) are given as normalised certainty equivalents. Higher values than 0.5 indicate risk aversion, lower values than 0.5 indicate risk seeking.

As for the gain domain, in the loss domain we did not detect any significant difference in risk aversion levels before and after the gambling session. We found no significance either in the 1 hour treatment group or in the 4 hours treatment group.

Lastly, Table 31 inspects variation in risk aversion. As before, this indicator is the difference between the risk aversion level after gambling minus the risk aversion level before gambling. The significant differences were assessed using the Mann-Whitney test, under which the null hypothesis was that the distribution of the variation in risk tolerance is equal between the 1 hour treatment and the 4 hours treatment. As we can see, there were no significant differences between the variation in risk aversion between a shorter and a longer session of gambling. And this holds both when considering the whole sample and when considering the division between problem and non-problem gamblers.

Table 31: Risk Tolerance Variations Loss Domain - 1 Hour treat. vs 4 Hours Treat -

Risk tolerance variations Loss domain	Mean Treat=1	Mean Treat=4	P value Mann-Whitney
Whole sample	+0.01	-0.03	0.472
Non-Problem gamblers	-0.06	+0.02	0.186
Problem gamblers	+0.05	-0.06	0.133

Differences of 10% and below are considered statistically significant.
*Risk tolerance variation is the difference between the risk aversion value after gambling menus the risk aversion value before gambling. This difference can be in a range between -1 and +1. In the loss domain this means that, higher values than 0 indicate that the risk aversion after gabling is increased (subjects have become less risk tolerant). On the contrary, lower values than 0 indicate that after gambling the risk aversion is decreased (subjects have become more risk tolerant).

To conclude, we want to underline three points. First, this analysis tells us that risk aversion (gain and loss domain) is not significantly affected by the activity of gambling, irrespective of its duration.

Second, using the Mann-Whitney test no significant differences were detected in risk aversion levels between problem and non-problem gamblers after gambling. And this evidence holds both for the gain and the loss domain, and for participants in both the 1 hour group and the 4 hours group. Therefore, this trait seems to be equal among gamblers at different stages of problematicity.

Third, we note from Tables 27 and 31 (those related to variation in risk aversion) that problem gamblers' risk aversion is characterised by a non-monotonic behaviour moving from the first hour of gambling to the long session of 4 hours. Risk aversion, in both the gain and loss domains, seems to increase after the first hour of gambling. However, after 4 hours of gambling the pattern is reversed and risk aversion decreases, making problem gamblers more tolerant to the risk. Even if these differences are not statistically significant, non-monotonic behaviour of risk aversion is unexpected and worthy of attention.

3.3.2 Loss Tolerance Variation

With the next analysis we want to study the effect of the gambling session on the levels of loss aversion by analysing the difference before and after the two treatments (1 and 4 hours). Before doing this, we want to examine whether there are significant differences in the pre/post levels irrespective of the session length. Table 32, on this regard, shows the values of the loss tolerance captured before and after the gambling sessions, irrespective of their length. In the first row are shown the values for the whole subject pool (86 observations), then the table displays the values for problem and non-problem gamblers. The last column shows the p-values from the Wilcoxon signed-rank test between the pre and the post value, indicating if there is a significance.

Table 32: Loss Aversion Pre/Post Gambling

Loss Aversion* values	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.36	0.31	0.172
Non-Problem gamblers	0.27	0.28	0.874
Problem gamblers	0.41	0.33	0.097*

Differences of 10% and below are considered statistically significant.
*Loss aversion values are given as normalised certainty equivalent. Higher values than 0.5 indicate loss seeking, lower values than 0.5 indicate loss aversion.

As we can see from the Table 32, the only significant difference is between the loss aversion before and after the gambling session in the problem gamblers group. In fact the loss aversion level of problem gamblers increase[30] of 0.08 points (p=0.097) after gambling, irrespective of the length of the treatment.

We will now analyse the variation in loss aversion, considering first the group subjected to the 1-hour treatment and then the group subjected to the 4-hour treatment. This will help us clarify whether a variation in the time spent in the agency could change the this trait in a different way. Table 33 shows the variation in the loss aversion before and after the 1-hour treatment, considering first the whole sample, irrespective of the problematicity. Then it shows the variation considering the division between problem and non-problem gamblers. As usual, the last column tells us if there is a significant difference in the pre/post variation by indicating the p-values from the Wilcoxon signed-rank tests.
Table 34 tells us the same information of Table 33 by considering participants of the 4 hours treatment group.

Table 33: Loss Aversion, Pre/Post 1 Hour Treatment

Loss Aversion* values	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.39	0.34	0.137
Non-Problem gamblers	0.31	0.31	0.873
Problem gamblers	0.45	0.36	0.076*

Differences of 10% and below are considered statistically significant.
*Loss aversion values are given as normalised certainty equivalent. Higher values than 0.5 indicate loss seeking, lower values than 0.5 indicate loss aversion.

Table 34: Loss Aversion, Pre/Post 4 Hours Treatment

Loss Aversion* values	Mean Pre gambling	Mean Post gambling	P value Wilcoxon test
Whole sample	0.32	0.27	0.696
Non-Problem gamblers	0.22	0.24	0.946
Problem gamblers	0.37	0.30	0.507

Differences of 10% and below are considered statistically significant.
*Loss aversion values are given as normalised certainty equivalent. Higher values than 0.5 indicate loss seeking, lower values than 0.5 indicate loss aversion.

In both treatment groups, loss aversion increases for problem gamblers: in the 1 hour group it

[30]Notice that loss aversion is given as normalised certainty equivalent. Low values indicate high loss aversion.

moves from 0.45 to 0.36; in the 4 hours group it goes from 0.37 to 0.30. However, only in the case of 1 hour of gambling is the variation statistically significant, with a Wilcoxon signed-rank test p-value of 0.076.

Finally, we look at Table 35 to inspect the difference between the variations in loss aversion when facing the 1 hour treatment group and the 4 hours treatment group. As we can see, there are no significant differences in any of the groups. If we look at the p-values, in fact, we can see that the 1 hour treatment shows about the same variations before and after the gambling session as the 4 hours treatment.

Table 35: Loss Aversion Variations, 1 Hour Treat. vs 4 Hours Treat.

Loss Aversion variations*	Mean Treat=1	Mean Treat=4	P value Mann-Whitney
Whole sample	-0.05	-0.04	0.480
Non-Problem gamblers	+0.01	+0.01	0.920
Problem gamblers	-0.09	-0.08	0.429

Differences of 10% and below are considered statistically significant.
*Loss aversion variation is the difference between the loss aversion value after gambling menus the loss aversion value before gambling. This difference can be in a range that goes from -1 to +1. Values higher than 0 indicate a decrease in loss aversion (subject has become more risk seeking after gambling). Lower values than 0 indicate an increase in loss aversion (subject has become more loss averse after gambling).

All the results above were quite unexpected. It is true, on one hand, that staying in the agency in general seems to increase the loss aversion of only problem gamblers. On the other hand, we can see significant increases only in the 1 hour treatment group. When we look at the 4 hours treatment group the loss aversion increase is not significant.

We want to underline that we conducted the same analyses controlling for the amount of money lost during the gambling session. This further investigation comes from the fact that our hypothesis on loss aversion variation was driven by a possible exposure to losses which should be characteristic of a longer session of gambling. A higher exposure to losses, compared to a lower one, could make gamblers less sensitive to losses. We implemented the analysis by imposing two restrictions on our sample. The first restriction was to retain only those subjects in the 4 hours treatment group who lost more money than the average amount lost by participants in both treatment groups (-27.5 Euro). The second restriction was to retain those subjects in the 1 hour treatment group who lost less money than the average amount lost by participants in both treatment groups (-27.5 Euro). We obtained similar results[31]to that shown in this section. For instance, after gambling the level of loss aversion increased. In addition, using the amount of money lost, this effect holds both for problem and non-problem gamblers, and for the 1 hour and 4 hours treatment groups in a significant way (all the p-values from the Mann-Whitney or Wilcoxon test are lower than 0.1.). Therefore, even controlling for the amount of money lost during the gambling session, the analysis shows that after gambling, loss aversion increased, and this was irrespective of the time spent gambling or the level of problem gambling detected.

[31]We do not show this further analysis since it was only a confirmation of our results. In addition, since we have taken only subjects with higher and lower amounts of losses, this last analysis could be affected by endogeneity issues.

3.4 The Effect of Gambling - Parametric Analysis

In the last section, we investigated the effect that our two treatments might have on gamblers' risk aversion and loss aversion. However, a further indicator of gambling activity is the amount of money staked during the session of gambling. The fact of staying longer in the betting agency cannot be considered a reliable indicator of more prolonged gambling activity. The experiment, in fact, allowed gamblers to gamble freely in the agency for a certain amount of time, but since we did not put any restriction on what they should do during the experiment, they could even have stayed in the agency without betting at all. For this reason the following analysis evaluates the effect that actual gambling expenditure had on variations in behavioural traits. Therefore, the amount of money spent during the free gambling session can give us a more accurate view of the gambling activity's effect.

We checked in section 4.2.1. whether a longer session implies a higher amount of money staked (either money lost and number of tickets bet and lost), compared to a shorter session. Since this was confirmed, we expect to find similar results to those of the non-parametric analysis.

We started by examining whether higher gambling expenditure produces different changes in behavioural traits than lower expenditure. Then we tested whether any effect of this kind is higher amongst problematic gamblers.

However, the amount spent gambling, taken alone, may not be the cause of a variation in behavioural traits. For instance, it could be the case that the gamblers who spend more are, at the same time, the gamblers whose behavioural traits vary more just because they are more addicted. Or it could even be the case that the variation in behavioural traits leads gamblers to enjoy gambling more, and for this reason they spend more money on it. These cases can be described as *reverse causality.* To ensure that these endogeneity issues do not affect our results we implemented a two-stage least squares regression (2SLS) using session length as an instrumental variable. In general, a valid instrument (in our case the session length) produces changes in the explanatory variable (gambling expenditure), but has no independent effect on the dependent variable (variation in behavioural traits), thus allowing the researchers to reveal the causal effect of the explanatory variable on the dependent one.

In detail, in order to test whether higher gambling expenditure causes a variation in behavioural traits we ran two different 2SLS regressions as follows: in both of the specifications the dependent variable was the variation in the given behavioural trait before and after the gambling session[32]. In the first specification the main explanatory variable was the *amount of money staked* during the gambling session. The amount of money staked is instrumented using the variable *treat* (a dummy variable equal to one if the subject belongs to the 4-hour group). In the second specification, in order to capture the effect on problem gamblers, we used as the explanatory variable the interaction term between money staked and belonging or not to the problem gamblers group. Also in this case we instrumented our main explanatory variable using the session length. Finally, we controlled for some socio-economic variables. Specifically, we included age, employment situation (low status indicator) and being an Italian citizen as control variables. We chose these specific controls because we consider these personal characteristics to be some of the major influencers of individuals' preferences. We decide to not include other betting controls to avoid collinearity problems. For instance, using this specification, we checked each variable using variable inflation analysis, obtaining an average vif value of 1.18[33]. In addition we had to consider that, since we were managing with a limited number of observations to avoid over-fitting, we had to exercise caution as to the number of controls included.

- $\Delta BE_i = B_0 + B_1 Money\ staked_i + B_2 Problem_i + B_3 Controls_i + \epsilon_i$
- $\Delta BE_i = B_0 + B_1 Money\ staked * Problem_i + B_2 Money\ staked_i + B_3 Problem_i + B_4 Controls_i + \epsilon_i$

In order to assess the robustness of the results, the same model was tested using different indicators of gambling activity. First, we tested the specification above using the number of tickets bet (as a main explicative variable) instead of the amount of money staked. Then the model was tested using the amount of money lost and the number of tickets lost during the gambling session. These last two indicators are particularly relevant for inspecting loss aversion variation. Indeed, according to our hypothesis, a possible decrease in loss aversion may be caused by an exposure to losses.

In order to make it easy to analyse results we show first a results concerning the impact on risk tolerance in the gain domain (Table 36), and then those regarding risk aversion in loss domain

[32]The variation was the normalised certainty equivalent of the trait measured post gambling minus the normalised certainty equivalent of the same trait measured before starting to gamble

[33]None of the variables included in the regression have a vif value higher than 1.31

(Table 37). Finally, we show the regression results about the impact on loss tolerance (Table 38).

3.4.1 Effect on Risk Aversion in the Gain Domain

Table 36 shows the regression results of the two specifications described above in terms of the variation in risk tolerance in the gain domain, in order to identify whether higher gambling expenditure affects the level of risk tolerance in the gain domain.

The 2SLS regressions were carried out using the variable *treat* as the instrument variable. Whether a participant was in the 1 hour or the 4 hours treatment group was exogenously decided, which helps eliminate possible endogeneity problems.
The first two columns show the OLS and the 2SLS regressions of the effect that spending a higher amount of money on gambling has on risk tolerance in the gain domain, considering the whole sample. Positive beta coefficients indicate a decrease in the level of risk aversion (increase in risk tolerance) in the gain domain after gambling (compared with the level before starting to gamble). Starting by observing the results from the first specification (Table 36, columns 1 and 2), we see the effect that a higher amount of money staked has on the variation in risk aversion level. Using the OLS estimation shows that a higher amount of money staked produces a significant increase in risk tolerance after gambling, when we instrument it using the exogenous treatment (column 2), this evidence is no longer significant. In contrast, in both of the estimations (OLS and 2SLS) being a problem gambler produces a significant increase in risk aversion level after gambling.
Columns 3 and 4 show the additional marginal effect that the combination of a higher expenditure on gambling and being a problem gambler has on risk aversion variation. Column 2 shows the 2SLS estimation. The results, as we can see, are all no longer significant, either the amount staked on gambling or the fact of being a problem gambler.

Two facts can be noted from the 2SLS estimation results (column 2): first, contrary to our hypothesis, it seems that what causes a significant variation in risk aversion after gambling is not the fact of having spent more money gambling, but rather the fact of being a problem gambler. Second, the direction of the risk aversion variation is the opposite of what we expected: problem gamblers became more risk averse after gambling.

As a further investigation, we ran the same specification using the following variables as main explicative variables instead of the amount of money staked:

- number of tickets bet

- amount of money lost

- number of losing tickets

For all the specifications the results were not significant, we chose not to include additional tables.

Table 36: Effect of Gambling on Risk Aversion - Gain domain

	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Amount of money staked	0.0005*	0.0004	0.0006	0.0011
	(0.078)	(0.633)	(0.207)	(0.730)
Money staked * Problem gambler			-0.0001	-0.0010
			(0.875)	(0.860)
Problem gamblers	-0.106**	-0.105*	-0.100	-0.0468
	(0.050)	(0.058)	(0.132)	(0.891)
Age	-0.0023	-0.0023	-0.0023	-0.0019
	(0.197)	(0.196)	(0.213)	(0.532)
Employed	0.0315	0.0351	0.0348	0.0648
	(0.606)	(0.586)	(0.593)	(0.745)
Italian citizen	0.0203	0.0233	0.0209	0.0267
	(0.720)	(0.694)	(0.714)	(0.696)
Constant	0.0724	0.0760	0.0646	-0.00569
	(0.570)	(0.556)	(0.639)	(0.990)
Observations	83	83	83	83
R^2 Adj.	0.0501	0.0474	0.0379	0.0128
P-value F-test	0.1103	0.2860	0.1772	0.1895

p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

For all the specifications the dependent variable is:

decrease in risk aversion in the gain domain (increase risk tolerance).

3.4.2 Effect on Risk Tolerance Loss Domain

The results below show the impact that higher expenditure in gambling had on the variation in risk aversion in the loss domain (before/after gambling). As before, we ran OLS and 2SLS regressions using the specifications shown in section 3.4 (p. 92).

The first two columns of Table 37 show OLS and 2SLS regressions using as the main explicative variable the amount of money staked during the gambling session. The 2SLS regression was done using the fact of being in the 1 hour treatment group or in the 4 hours treatment group as the instrument variable.

We observe that spending a higher amount of money gambling had no significant impact on risk aversion in the loss domain.

The last two columns show the additional marginal impact that the interaction between a higher expenditure on gambling and being a problem gambler has on risk aversion in the loss domain. Indeed, the variable *money staked*problem gambler* captures the combined effect on risk aversion of both a higher expenditure and belonging to the problematic group.

Also in this case, the 2SLS regression totally fails to explain the variation in risk aversion in the loss domain before/after gambling (see F-test p-value and R^2 adj). This could also be due to the fact that in general there is no significant variation in the level of risk aversion before and after gambling, as confirmed by the results of the non-parametric analysis (see Section 3.3.1).

We further investigated whether the results were consistent even if we used other indicators of gambling activity (number of tickets bet and lost, and amount of money lost), and the results were quite similar to those shown in Table 37. We decided to not include additional tables in order to avoid repetition.

Table 37: Effect of Gambling on Risk Aversion - Loss domain

	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Amount of money staked	0.0005	-0.0006	0.0006	0.0049
	(0.187)	(0.548)	(0.301)	(0.395)
Amount of money staked * Problem gambler			-0.0002	-0.0079
			(0.809)	(0.440)
Problem gambler	0.0474	0.0611	0.0584	0.522
	(0.459)	(0.376)	(0.459)	(0.402)
Age	-0.0016	-0.0017	-0.0015	0.00173
	(0.443)	(0.457)	(0.472)	(0.750)
Employed	-0.0915	-0.0630	-0.0853	0.173
	(0.211)	(0.439)	(0.273)	(0.631)
Italian citizen	0.0986	0.122	0.0998	0.150
	(0.147)	(0.105)	(0.146)	(0.229)
Constant	0.0217	0.0502	0.0073	-0.600
	(0.886)	(0.758)	(0.965)	(0.474)
Observations	83	83	83	83
R^2 Adj.	0.0255	.	0.0134	.
P-value F-test	0.2234	0.4068	0.3229	0.7323

p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

For all the specifications the dependent variable is:

Increase in risk aversion in the loss domain(decrease in loss tolerance).

3.4.3 Effect on Loss Aversion

Table 38 shows the regression analysis we carried out in order to see whether a higher amount of gambling expenditure had an impact on loss aversion. The dependent variable for all the regressions was *decrease in loss aversion* (increase in loss tolerance) after gambling. This captured the difference between the level of loss aversion before and after gambling. Positive beta coefficients indicate that after gambling there was a reduction in the level of loss aversion.

The first two columns display the results of the OLS and 2SLS regressions, in which the main explicative variable was the amount of money staked during the session of gambling. Its coefficient indicates the impact that higher gambling expenditure had on loss aversion variation.
As we can see from Table 38, the amount of money staked on gambling produces a significant decrease in the level of loss aversion only using the OLS estimation (p-value=0.078), meaning that subjects became more loss tolerant due to higher gambling expenditure. When we instrument money staked with the fact of being in the 1 hour or 4 hours treatment group (using the dummy variable *treat*), the impact is no longer significant (p-value=0.633). What is still significant moving from the OLS estimation to the 2SLS is the impact of the variable problem gamblers. For instance, being a problem gambler raises the probability of an increase in loss aversion after gambling (negative beta coefficient).
The last two columns of Table 38 show the OLS and the 2SLS regressions using as main explicative variable the interaction term between the amount of money staked on gambling and the fact of being a problem gambler. This interaction term shows the additional marginal effect that a higher expenditure on gambling and being problem gambler have on the variation in loss tolerance.
In both cases the interaction term gives us a non-significant impact on loss aversion. It seems that gambling expenditure does not affect an individual's loss aversion, and neither does combining the effects of higher expenditure and being a problem gambler.
As the beta coefficients of the variable *money staked* are positive (producing a decrease in loss aversion), it seems that the parametric analysis gives us opposite results to the non-parametric analysis (3.3.2), and that the direction of the effect (gambling raises loss tolerance) is in line with our expectation.

Table 38: Effect of Gambling on Loss Aversion

	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Amount of money staked	0.0005*	0.0004	0.0006	0.0011
	(0.078)	(0.633)	(0.207)	(0.730)
Amount of money staked * Problem gambler			-0.0001	-0.0010
			(0.875)	(0.860)
Problem gambler	-0.106**	-0.105*	-0.100	-0.0468
	(0.050)	(0.058)	(0.132)	(0.891)
Age	-0.0023	-0.0023	-0.0023	-0.0019
	(0.197)	(0.196)	(0.213)	(0.532)
Employed	0.0315	0.0351	0.0348	0.0648
	(0.606)	(0.586)	(0.593)	(0.745)
Italian citizen	0.0203	0.0233	0.0209	0.0267
	(0.720)	(0.694)	(0.714)	(0.696)
Constant	0.0724	0.0760	0.0646	-0.0057
	(0.570)	(0.556)	(0.639)	(0.990)
Observations	83	83	83	83
R^2 Adj.	0.0501	0.0474	0.0379	0.0128
P-value F-test	0.1103	0.2860	0.1772	0.1895

p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

For all the specifications the dependent variable is:
decrease in loss aversion (increased loss tolerance).

As in the case of risk aversion, we further investigate the effect of gambling activity on loss aversion by using different indicators of gambling activity. Since our hypothesis was that the more a subject experiences losses the more he become less sensitive for losses (less loss averse), the fact of controlling for the amount of losses experienced by the subject is something important in the case of loss aversion.

Even using the others indicators of gambling activity the results are exactly the same of those shows in Table 38. We decided to not add additional tables in order to avoid repetitions.

3.5 Gamblers' Behaviour Over Time

Focusing on the literature on risk propensity among problem gamblers, we found controversial results. Some studies sustain the view that gamblers are risk-seeking (R. Ligneul et al., 2013). Some others say that a diminishing sensitivity pattern has an important role in explaining risk-seeking behaviour (Richard H. Thaler, Eric J. Johnson, 1990). This implies that the level of risk seeking increases as the amount of losses increases. Therefore, from this viewpoint gamblers become risk-seeking only after a certain amount of accrued losses.
We posit our expectations following this last hypothesis. In particular the fact of experiencing losses during gambling may explain a possible increase in both loss and risk tolerance. However, the results of the previous parametric analysis showed no significant impact of the amount of money staked/lost on the risk/loss tolerance variation [34].

In this last part of the analysis we want to look at risk propensity behaviour from a different point of view. Until now we have analysed risk aversion before and after a session of gambling using experimental tasks. We now want to look at the odds that gamblers chose during their gambling sessions, and the money they staked on each bet[35]. *Odds* and *money staked* are, in fact, the two risk indicators of their actual gambling behaviour, and tracing them will permit us to observe what actually happened to the gamblers' risk aversion levels during the session.

We start by analysing the average odds and the average amount of money staked per hour in the 1-hour treatment and in the 4-hour treatment, considering problem and non-problem gamblers separately. Tables 39, 40, and 41 show the results. In particular, Table 39 displays in the first column the average odds chosen by the subjects, irrespective of the gambling session duration. In the second column are shown the average odds bet on by gamblers in the 1 hour treatment and, in the third column, the average odds chosen in the 4 hours treatment. Finally, the last column displays the p-value of the Mann-Whitney between the odds of two treatment groups. All of the results are shown first for the whole sample and then divided according to the division between problem and non-problem gamblers.

[34] We find that the amount of money staked/lost during gambling significantly increased risk tolerance in the gain domain and increased loss tolerance only when using OLS estimation (Table 36, column 1; Table 38, column 1). When we estimated coefficients using 2SLS estimation in order to deal with endogeneity problems, the results became no longer statistically significant.

[35] Since we collected all the betting receipts for each participant, we actually have this information.

Table 39: Average *Odds* Bet in Different Gambling Sessions

	Mean Treat1+Treat4	Mean Treat=1	Mean Treat=4	P value Treat1-Treat4
Whole sample	31.4	38.9	21.8	0.674
Non-Problem gamblers	36.2	47.5	21.6	0.909
Problem gamblers	28.4	33.4	21.9	0.891
P-value Mann-Whitney Problem vs Non problem gamblers	0.291	0.392	0.604	

Table 40: Average *Odds Bet Weighted* in Different Gambling Sessions

	Mean Treat1+Treat4	Mean Treat=1	Mean Treat=4	P value Treat1-Treat4
Whole sample	21.6	24.4	18.1	0.716
Non-Problem gamblers	27.5	33.6	19.7	0.790
Problem gamblers	17.8	18.5	17.0	0.953
P-value Mann-Whitney Problem vs Non problem gamblers	0.607	0.621	0.974	

Table 41: Average *Money Staked per Hour* in Different Gambling Sessions

	Mean Treat1+Treat4	Mean Treat=1	Mean Treat=4	P value Treat1/Treat4
Whole sample	30.2	36.6	22.4	0.010**
Non-Problem gamblers	28.1	34.1	20.5	0.025**
Problem gamblers	31.4	38.2	23.4	0.168
P-value Mann-Whitney Problem vs Non problem gamblers	0.758	0.424	0.588	

Tables 40 and 41 are in the same format as Table 39 and show, respectively, the average odds weighted by the amount staked on each odds and the average amount of money staked per hour. As we can see in Tables 39 and 40, analysing the variation in odds using a non-parametric analysis, the differences in the odds used between the shorter and the longer sessions of gambling are never significant.

In Table 41 we take into consideration the average amount of money staked per hour. We observe that in every case there is a large reduction in the amount spent per hour when moving from the 1 hour to the 4 hours treatment group. Notice that the significant reduction is mainly due to that in the non-problem category.

3.5.1 Gamblers Behaviour Over Time - Parametric Analysis

After the analysis shown above, we ran a series of dynamic panel data regressions, using the GMM estimation by Arellano and Bond (1991). In this way, we analysed the gamblers' risk behaviour using two dimensions: subjects and time. Our main objective was to look at the individuals' risk level variation over time (during the gambling session). In particular, we want to observe whether as the amount of money lost increased, the willingness to take additional risk increased too.

The data we took into account in order to run this series of regressions were all of the tickets bet per subject, ordered by the time they were bet. This information comes from the free gambling session.

We followed the specification shown below.

- $Risk_{i,t} = B_i + B_1\textbf{Net Money Lost}_{i,t-1} + B_2\text{Risk}_{i,t-1} + B_3\text{Risk}_{i,t-2} + B_4\text{Risk}_{i,t-3} + B_5\text{Game no skill}_{i,t} + \epsilon_{i,t}$

The dependent variable *Risk* is the level of the risk that subject i was taking at time t (on the current bet). We use three different indicators of risk taken at time t for subject i:
- the *money staked* from subject i in the current bet;
- the *odds* bets from subject i in the current bet;
- the *odds weighted by the money staked* by subject i in the current bet.

The main explanatory variable is the net money lost until the previous period (time t-1)[36]. Where higher values of the variable indicate higher amounts of money lost.

As control variables we included three lags of the dependent variable (risk taken by subject i at time t). These controls (lags) seek to ensure that some particular individual's trend in the risk taken does not bias our results. As a further control we added one more variable: (*Game no skill*) which was a dummy variable equal to 1 if the bet at time t by subject i was placed on a game which did not involve the use of skill (e.g virtual races). This information could capture the fact that different type of games could imply different levels of risk.

Several other decisions have to be taken when using the GMM estimations. We provide a brief

[36] The robustness of the results is addressed by varying the number of lags included in the specification.

explanation of those taken to perform our estimation. First of all, the Arellano and Bond estimator is designed for datasets with many panels and few periods, and it requires that there is not autocorrelation in the idiosyncratic errors. According to this, the Arellano-Bond test for zero autocorrelation in first-differenced errors was performed.

Secondly, we chose to implement System GMM estimation following the rule of thumb indicated by Bond (Blundell, R., and Bond, S., 1998), which states that an autoregressive model should be estimated initially using OLS and fixed effect. These two estimations should be considered the upper and lower bound estimates, respectively. Then, if the difference GMM estimate is close to or below the fixed effect estimate, this suggests that difference GMM is downward biased because of weak instrumentation and System GMM is preferable. After this procedure we decided to implement System GMM. Third, an exaggerated number of instruments is often a cause of bias in estimations, as suggested by D. Roodman (2009). Indeed, a large instrument collection overfits endogenous variables, and this often leads to a high number of false positive results. This danger exists even if the Hansen test of the instruments' joint validity gives a positive result. For these reasons, we followed the suggestions of D. Roodman (2009) by limiting the numbers of instruments generated in System GMM. We achieved this using two different techniques. The first was to use only certain lags instead of all those available for instrumenting. In particular, we set at 15 the number of lag variables for instrument. The second technique adopted was to collapse instruments. The final specification ended up having 21 instruments, 74 groups, and 1,113 observations. Within endogenous instruments we included lag variables of the dependent variable and lag variables of the net money lost (our main explanatory variable). Within the exogenous instruments we included the dummy variable "treat", equal to 1 if the subject participated in the longer session of gambling, and the variable "ticket time", which indicates the order in time of the tickets issued for subject i. Moreover, we implemented two step estimation using the command "robust". In two-step estimation, where the errors are already robust, this command triggers the Windmeijer correction. Lastly, we carried out a forward orthogonal-deviations transformation. This procedure is quite common when panel data are unbalanced D. Roodman (2009). The GMM estimator, in fact, has the unfortunate feature of magnifying any gaps in the data: when a period is missing it is replaced with two missing differences. Orthogonal deviations transform each observation by subtracting the average of all future observations.

Since experimentation is the only way to ensure that results are reasonably robust against variations in the instrument collection and lags used, all the results were tested by varying the number of instruments from 8 to 54 and by varying the number of lags included as regressors. Others tests were done by using one step and non-orthogonal estimation. Some other tests were done by adding ticket time (time trend) within the regressors. And for all these different specifications the results remained almost the same.

Table 42 shows the results.

Table 42: Dynamic Effect of Money Lost on Risk Propensity Over Time

	(1) Risk	(2) Odd	(3) Money staked
L1.Net Amount Lost	0.702***	0.191	0.0246**
	(0.002)	(0.447)	(0.038)
L1.Risk	-0.0253***		
	(0.001)		
L2.Risk	-0.0446		
	(0.479)		
L3.Risk	0.178		
	(0.160)		
L1.odds		-0.0088	
		(0.545)	
L2.odds		0.0458	
		(0.829)	
L3.odds		0.314	
		(0.119)	
L1.Money staked			0.221***
			(0.009)
L2.Money Staked			0.0515
			(0.421)
L3.Money Staked			0.0585
			(0.310)
Game No Skill	7.538	24.80	-0.492
	(0.772)	(0.121)	(0.507)
Constant	20.86	0.621	1.360**
	(0.231)	(0.973)	(0.022)
Observations	1113	1113	1143
F-test P-value	<0.001	<0.001	<0.001
Groups/Instruments	74/21	74/21	74/21
AR(2)	0.951	0.728	0.744
Hansen Statistic	0.574	0.795	0.388

p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The dependent variable Risk indicates:
the odds bet at time t weighted for the amount of money staked on this bet.
The main explanatory variable is *Net Amount Lost* until time t-1,
higher values of the variable indicate higher amount of losses collected.

Table 42 shows the results of the specification shown above. Column (1) shows the effect that the amount of money lost in the previous period has on the risk taken in the current bet, where the dependent variable Risk indicates the odds bet weighted by the amount of money staked on this bet. Column (2) shows the same effects, but the dependent variable in this case is the odds bet in the current bet. Finally, column (3) shows the effect of money lost on the amount of money staked in the current bet. As we can see, the higher the amount of money lost gambling in the previous period, the higher the risk taken in the current bet. And this result is statistically significant when using as risk indicators the odds weighted by the amount staked (potential gain) and the amount staked in the current bet (p-values of 0.002 and 0.038, respectively). The other variables, with the exception of the first lag of the dependent variable (L.Risk/L.Money Staked), are all not statistically significant in explaining the risk taken with the current bet by subject i. These findings are in line with our expectations. According to this, the higher losses amassed during gambling activity lead gamblers to take additional risk, despite the losses. However, this analysis cannot distinguish whether this additional risk is driven more by an increase in loss tolerance or by an increase in risk tolerance.

In the next section we will discuss the overall results of this chapter.

4 Discussion

The analysis of this chapter has aimed to investigate the possible causal relationship between the activity of gambling and some specific behavioural traits.

The previous analysis (Chapter 2), using experimental tasks to measure behavioural traits, raised some doubts as to whether these traits can be considered as reliable predictors of the level of addiction or gambling activity overall. This was especially true for risk aversion.

The only significant difference we detected was that, before starting to gamble, the level of loss aversion was different between problem and non-problem gamblers. In particular, problem gamblers seemed to tolerate more losses than non-problem ones.

Despite the scarce evidence, several empirical studies of this argument have found that behavioural traits could discriminate between different type of gamblers (R. Ligneul et al., 2012; H. Takeuchi et al.,2016; Brevers et al., 2012; Gelskov et al., 2016; Giorgetta et al., 2014; Ring, P. et al., 2018; J. Grossman and C. Eckel, 2015). In particular, many of them find that gamblers are, in general, more risk tolerant and more loss tolerant than non-gambler subjects. In the present work we ask whether some of these behavioural differences could be caused by the gambling activity. Therefore, we started from the findings of such studies to ask about the causality relationship between differences in behavioural traits and gambling activity. According to the framework offered by Prospect Theory we expected that both loss aversion and risk aversion should decrease due to gambling activity. Indeed, gambling implies experiencing losses by its very nature, and the longer the time spent gambling, the more the losses that the gambler experiences. On one hand, this could have a desensitising effect on the subject's loss aversion. On the other hand, the diminishing marginality pattern might explain the increase in the risk taken by gamblers during gambling, despite losses. We tested this hypothesis by using an exogenous treatment which randomly allocated gamblers to a shorter or a longer session of gambling.

Two methods were used to address this research question. The first one aimed to observe any possible variation in the level of behavioural traits by measuring them using experimental tasks, before and after the gambling session. The second method aimed to look at the gamblers' actual behaviour over time during the gambling session, by keeping track of the participants betting receipts from the session.

The method that used experimental tasks brought us almost no significant results. Using a non-parametric analysis, the only variation observed was in the level of loss tolerance of problem gamblers, which decreased after the short session of gambling. No effect was detected related to the long gambling session.

Using a parametric analysis we tried to link the amount of money spent and lost during gambling with possible variations in behavioural traits. Using the 2SLS regression, no link was detected between gambling expenditure and variations in behavioural traits (via experimental tasks). However, we detected that the problem gamblers category decreased their level of risk and loss tolerance after gambling, irrespective of their gambling expenditure (and irrespective of the length of the gambling session).

These findings were quite unexpected. Problem gamblers became more loss and risk averse after gambling compared with the level detected before gambling. In addition, this result seems unrelated to either the amount spent or the losses collected.

The second method looked at the gamblers' actual behaviour over time by examining their betting receipts. We looked at the risk taken by every subject for every bet placed from the beginning to the end of the free gambling session. In this case our indicator of risk was both the actual odds bet and the actual amount of money staked at each odds by the gamblers. Using a GMM estimation we observed the dynamic variation of the risk taken for every bet, depending on the amount of losses collected up until the current bet.

Interesting results came up. We found that both the amount staked and the odds weighted for the amount staked were significantly affected by past losses: the more losses they have collected during gambling, the more is the risk that gamblers are likely to take in the current bet. These results are in accordance with our framework. We attribute this pattern in particular to the diminishing marginality phenomenon. Gambling exposes gamblers to repeated losses, thus making them less sensitive to additional losses. This could explain the higher risk they continue to take, despite losses.

This finding is explained using Prospect Theory by assuming that there are situations in which gains and losses are coded relative to an expectation level that differs from the status quo (Kahneman and Tversky, 1979, p 286). This happens during an editing phase in which prospect and outcomes are simplified and encoded by subjects. According to this, prior outcomes have an impact on subsequent choices.

The variation in preferences that we found explains the commonly found trend of time inconsistency between initial planned strategy and the gambler's actual behaviour. Indeed, higher initial risk aversion may induce the gambler to plan a lower-risk gambling session; however, the lowering of the aversion level during the session leads the gambler not to respect his plan and to act in a more risky way. This is confirmed by the fact that gamblers typically end up taking more risk and spending more money than they had planned (E. B. Andrade and G. Iyer, 2008; N. Barberis, 2010).

The two methods used to inspect the relation between gambling activity and behavioural traits gave us opposite results. However, we have to consider that they actually measured different things. The first one measured behavioural traits via experimental tasks, whereas the second one looked at the actual risk taken during the gambling session. We can hypothesise that, in the first case, gamblers do not perceive the experimental tasks as real gambling moments, thus explaining why they behave in a different way compared with during the actual gambling session. We can speculate that these differences come from the fact that real gambling is structurally different from experimental tasks that always offer a certainty amount choice (in our case, the MPL method). This could have led gamblers to experience these tasks as an easy way to make money. After the gambling session, the urge to make new money by continuing to gamble may have led gamblers (in particular problem gamblers) to behave in a more risk and loss averse way in order to collect the most possible and most sure amount of money.

We can conclude that gambling activity actually has an impact on gamblers' preferences. However, there is a difference in subjects' risk aversion if we look at it using experimental tasks or if we look at it directly from observing actual gambling activities. Therefore, it seems that it is the gambling mechanism itself, which combines the feeling of risk and repeated losses, which brings an increase in subjects' risk tolerance, thus leading them to continue gambling, and even to take additional risk.

These results could be important, first of all because they underline important differences between real and experimental obseravtion. Specifically, the results suggest that it is necessary to carefully compare preferences elicited using experimental tasks with those observed during the activity of gambling. Second, our results indicate that gamblers are not risk-seekers in general, but their risk propensity seems to rise when they are involved in gambling. Third, the major effect on the gamblers' risk propensity seems to be attributable to the amount of losses collected in past outcomes.

The evidence brought by this study led us to conclude that it was not behavioural traits per se that are the cause of problematicity in the gambling context. However, the initial increase in a subject's risk tolerance due to gambling activity could trigger a vicious circle in which it is the augmented risk tolerance which leads the subject to continue gambling despite the losses. This mechanism share some similarities with substance addiction (as the American Psychiatric Association suggests in the latest edition of the DSM-V). To confirm similarities between gambling and substance addiction is important for at least two reasons: firstly, because it makes gambling addiction treatable using similar approaches to the treatment of substance addiction; secondly, because it forces us to treat gambling as a good that cannot be sold in the market as a standard good, but instead has to be appropriately regulated like other potentially damaging products.

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6 Appendix 1

Below is shown the whole text of the experiment, including instriction, payment method, tasks, and questionnaire.

6.1 Instruction

Thank you for participating in this experiment of behavioural economic. Please read, and listen to, the following instructions carefully.

You will receive 20 Euro for participating in and completing the whole experiment. This will imply storing and giving us all the losing-tickets that you betted in the agency during the time of the experiment.

You also have the opportunity to earn more money (a variable amount) depending on the decisions you make during the experiment. Your total payment will be the fixed amount of 20 euro plus the variable amount. Your earnings will be paid out in cash at the end of the experiment, before you leave.

The experiment you are participating in consists of 2 parts: - the first part takes 20 minutes. During this time we will ask you to take some decisions.

At the end of this first part, you will be free to gamble in the betting agency.

The only requirement we ask you is to collect all your agency betted and losing tickets and store them in a proper bag (we provide it).

Notice that, if some tickets will be lost or switched the experiment remuneration will no longer be guaranteed. - the second part of the experiment will take place during this day , we will call you then (maximum 4 hours). It takes 10 minutes and, as in the first part, the requirements will be to take some decisions and to answer a series of questions about your personal characteristics and about your gambling habits.

The questionnaire is completely anonymous. It is associated with a number. Your identity is not required.

All the information you will give during this experiment will be used only for research purposes.

So, please be honest answering the questions.

Good Luck!!!

6.2 Payment instructions

During the experiment you have to take some decisions that can produce both earnings and losses. Take your choices with attention! You will take 94 decisions, each of them between two options. At least one of the two options will be a lottery.

At the end of the experiment one of the 94 choices will be randomly chosen and paid according with your choice: - If you have chosen the certain amount of money, you will get this amount.

- If you have chosen the lottery then, the lottery will be really played and paid according to the lottery outcomes.

For example, if your decision is to take a lottery which gives you a 50% chance of earning 50 Euro, and a 50% chance of earning nothing, then a ball will be drawn from an urn which contains 50 white balls and 50 black balls.

- If the white ball is drawn then you will win 50 Euro.
- If the black ball is drawn then your earnings will be zero.

6.3 Part 1

BRET:

Consider the followed situation: An Urn contains 100 balls in total

- 99 balls are white

- 1 ball is black

Your task is to choose how many balls you want to draw from the urn (minimum 1 and maximum 100). Knowing that:

- For each ball collected you can earn 1 Euro

- If you draw the black ball your earn in this game will be zero

Notice that, since nobody can predict when the black ball will be draw, there is not a right answer. Therefore collect the number of balls you think best.

Ask if something is not clear.

How many balls do you want to collect?

AMBIGUITY AVERSION TASK:

There are 2 Urns:

- Urn 1: there are 90 balls

  - 30 red

  - the others 60 balls are drawn randomly from a bag which contain 120 balls, half blue and half yellow

- Urn 2: there are white and black balls. The right composition will be given for each option

Option A: You win 50 euro if a red ball is randomly drawn from Urn 1. And nothing otherwise.

Option B: You win 50 euro if a white ball is randomly drawn from Urn 2. And nothing otherwise.

The right proportion of the white and black balls are given for each row of the column option B.

	TEST 1			
	OPTION A	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B** **WIN 50 euro if the WHITE ball is drawn**
2				**24 WHITE - 76 BLACK**
3				**26 WHITE - 74 BLACK**
4	**You win 50 Euro** if a **RED ball**			**28 WHITE - 72 BLACK**
5	is drawn from the **urn 1.**			**30 WHITE - 70 BLACK**
6	(and nothing otherwise)			**32 WHITE - 68 BLACK**
7				**34 WHITE - 66 BLACK**
8				**36 WHITE - 64 BLACK**
9				**38 WHITE - 62 BLACK**
10				**40 WHITE - 60 BLACK**
11				**42 WHITE - 58 BLACK**

Option A: You win 50 euro if a blue ball is randomly drawn from Urn 1.Nothing otherwise.

Option B: You win 50 euro if a white ball is randomly drawn from Urn 2.And nothing otherwise.

The right proportion of the white and black balls are given for each row of the column option B.

	TEST 2			
	OPTION A	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B** **WIN 50 euro if the WHITE ball is drawn**
12				**24 WHITE - 76 BLACK**
13				**26 WHITE - 74 BLACK**
14	**You win 50 Euro** if a **BLUE ball**			**28 WHITE - 72 BLACK**
15	is drawn from the **urn 1**.			**30 WHITE - 70 BLACK**
16	(and nothing otherwise)			**32 WHITE - 68 BLACK**
17				**34 WHITE - 66 BLACK**
18				**36 WHITE - 64 BLACK**
19				**38 WHITE - 62 BLACK**
20				**40 WHITE - 60 BLACK**
21				**42 WHITE - 58 BLACK**

Option A: You win 50 euro if a yellow ball is randomly drawn from Urn 1. And nothing otherwise.

Option B: You win 50 euro if a white ball is randomly drawn from Urn 2. And nothing otherwise.

The right proportion of the white and black balls are given for each row of the column option B.

	TEST 3			
	OPTION A	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B** **WIN 50 euro if the WHITE ball is drawn**
22				**24 WHITE - 76 BLACK**
23				**26 WHITE - 74 BLACK**
24	**You win 50 Euro** if a **YELLOW ball**			**28 WHITE - 72 BLACK**
25	is drawn from the **urn 1.**			**30 WHITE - 70 BLACK**
26	(and nothing otherwise)			**32 WHITE - 68 BLACK**
27				**34 WHITE - 66 BLACK**
28				**36 WHITE - 64 BLACK**
29				**38 WHITE - 62 BLACK**
30				**40 WHITE - 60 BLACK**
31				**42 WHITE - 58 BLACK**

RISK AVERSION TASK IN THE GAIN DOMAIN

Option A: In an Urn there are 50 white balls and 50 black balls.

- You win 50 Euro if the white ball is drawn.
- Nothing if a black ball is drawn.

Option B: You win an increasing amount of money for sure (see the amounts for each row in column option B).

Write you favourite option, between A and B, for each row.

	TEST 4			
	OPTION A	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B** **WIN for sure**
32				**5 Euro**
33				**10 Euro**
34				**15 Euro**
35	**You win 50 Euro** if the **WHITE ball**			**20 Euro**
36	is drawn.			**25 Euro**
37	(and nothing otherwise)			**30 Euro**
38				**35 Euro**
39				**40 Euro**
40				**45 Euro**

RISK AVERSION TASK IN THE LOSS DOMAIN

The following choices produce LOSSES.

To participate this game we endow you with 50 Euro.

In this way the possible losses will be deduct from this initial endowment. Example: If your choice produces a loss of 45 Euro than you end up with 5 Euro in your pocket.

Option A: In an Urn there are 50 white balls and 50 black balls.

- You lose 50 Euro if the BLACK ball is drawn.
- You lose nothing if a white ball is drawn.

Option B: You lose an increasing amount of money for sure (see the amounts for each row in column option B).

Write you favourite option, between A and B, for each row.

	TEST 5			
	OPTION A	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B** **LOSE for sure**
41				**45 Euro**
42				**40 Euro**
43				**35 Euro**
44	**You lose 50 Euro** if the **BLACK ball**			**30 Euro**
45	is drawn.			**25 Euro**
46	(and nothing otherwise)			**20 Euro**
47				**15 Euro**
48				**10 Euro**
49				**5 Euro**

LOSS AVERSION TASK

The following choices may produce LOSSES.

To participate this game we endow you with 25 Euro.

In this way the possible losses will be deduct from this initial endowment. Example: If your choice produces a loss of 20 Euro than you end up with 5 Euro in your pocket.

Option A: In an Urn there are 50 white balls and 50 black balls.

- You win 25 Euro if the WHITE ball is drawn.
- You lose 25 Euro if the BLACK ball is drawn.

Option B: Lose or win an increasing amount of money for sure (see the amounts for each row in column option B).

Write you favourite option, between A and B, for each row.

	TEST 6			
	OPTION A	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B** **LOSE/WIN for sure**
50				**-20 Euro**
51				**-15 Euro**
52	**You win 25 Euro** if a **WHITE** ball			**-10 Euro**
53	is drawn,			**-5 Euro**
54	**you lose 25 Euro** if a **BLACK** ball			**0 Euro**
55	is drawn.			**+5 Euro**
56				**+10 Euro**
57				**+15 Euro**
58				**+20 Euro**

Option A: Win for sure 25 euro

Option B: In an urn there are white and black balls. The right composition will be given for each option.

- Win 300 euro with if a WHITE ball is randomly drawn.
- And nothing if the black ball is randomly drawn.

Write you favourite option, between A and B, for each row.

	TEST 7			
	OPTION A	Mark if you prefer option A	Mark if you prefer option B	OPTION B WIN 300 euro if the WHITE ball is drawn
59				1 WHITE - 99 BLACK
60				2 WHITE - 98 BLACK
61				3 WHITE - 97 BLACK
62	Win for sure 25 EURO			4 WHITE - 96 BLACK
63				5 WHITE - 95 BLACK
64				6 WHITE - 94 BLACK
65				7 WHITE - 93 BLACK
66				8 WHITE - 92 BLACK

COIN TOSS TASK

Consider the following situation:

A coin is tosses 3 times, and we show the results below. Now you have to bet on the event the next coin toss result is HEAD (4th toss).

You can bet any amount between 0 and 25 Euro for each case.

- If the next coin toss is TAIL than the betted amount will be lost.

- If the next coin toss is HEAD then you will win twice the betted amount Please write down how much you want to bet for each of the 4 cases.

If this game is drawn to determinate your payment, we endow you with 25 euro and one of these 4 cases will be randomly played.

	Coin tosses results				
	1 toss	2 toss	3 toss	**Forecast of toss 4**	**AMOUNT YOU WANT TO BET**
Case 1:	HEAD	HEAD	HEAD	**HEAD**	
Case 2:	HEAD	TAIL	HEAD	**HEAD**	
Case 3:	TAIL	HEAD	TAIL	**HEAD**	
Case 4:	TAIL	TAIL	TAIL	**HEAD**	

TIME PREFERENCES TASK

The following choices will not randomly drawn for you payment/compensation. However, we ask you to take your decisions as if they were real.

Option A: Receive 50 euro today

Option B: Receive an increasing amount tomorrow (see the amounts for each row in column option B).

Write you favorite option, between A and B, for each row.

TEST 9			
OPTION A RECEIVE TODAY	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B RECEIVE TOMORROW**
			49,0
			49,5
			49,9
50 Euro today			**50,0**
			50,1
			50,5
			51,0
			52,0
			53,0

Option A: Receive 50 euro today

Option B: Receive an increasing amount in a month (see the amounts for each row in column option B).

Write you favorite option, between A and B, for each row.

TEST 10			
OPTION A RECEIVE TODAY	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B RECEIVE IN A MONTH**
			19,2
			35,2
			45,9
50 Euro today			**50**
			54,1
			64,8
			79,6
			109,2
			138,8

Option A: Receive 50 euro tomorrow.

Option B: Receive an increasing amount in a month (see the amounts for each row in column option B).

Write you favorite option, between A and B, for each row.

TEST 11			
OPTION A **RECEIVE TOMORROW**	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B** **RECEIVE IN A MONTH**
			20,2
			35,7
			46
50 Euro tomorrow			**50**
			53,9
			64,3
			78,6
			107,2
			135,8

The following temporal decisions regard payments

Option A: Pay 50 euro today.

Option B: Pay an increasing amount tomorrow (see the amounts for each row in column option B).

Write you favorite option, between A and B, for each row.

TEST 12			
OPTION A PAY TODAY	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B PAY TOMORROW**
			53,00
			52,00
			51,00
50 Euro today			**50,50**
			50,10
			50,00
			49,90
			49,50
			49,00

Option A: Pay 50 euro today.

Option B: Pay an increasing amount in a month (see the amounts for each row in column option B).

Write you favorite option, between A and B, for each row.

TEST 13			
OPTION A PAY TODAY	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B PAY IN A MONTH**
			138,80
			109,20
			79,60
50 Euro today			**64,80**
			54,10
			50,00
			45,90
			35,20
			19,20

Option A: Pay 50 euro tomorrow.

Option B: Pay an increasing amount in a month (see the amounts for each row in column option B).

Write you favorite option, between A and B, for each row.

TEST 14			
OPTION A PAY TOMORROW	Mark if you prefer **option A**	Mark if you prefer **option B**	**OPTION B PAY IN A MONTH**
			135,80
			107,20
			78,60
50 Euro tomorrow			**64,30**
			53,90
			50,00
			46,00
			35,70
			20,20

Personal characteristics are inspected using self-reported questionnaire

End of Part 1

6.4 Part 2 (after free gambling session)

Gambling session questions:

1. How much money did you plan to spend betting today before entering the agency? Did you follow your plan?

2. How much did you bet today gambling (total), considering both your money and the money won during gambling?

3. How much money do you have now in your wallet? It is more or less with respect the moment you arrived in the betting agency?

Answer the following questions only if you have played the electronic gambling machines:

1. How much did you bet today on electronic gambling machines (total), considering both your money and the money won during gambling?

2. How much money do you have now in your wallet? It is more or less with respect the moment you started to play electronic gambling machines?

3. How much time did you spend today playing the electronic gambling machines?

Re-tested risk aversion and loss aversion using multiple prize list, as in the part 1.

Gambling disorder (DSM-V):

The following questions regard your gambling habits.

We remind you that the questionnaire is completely anonymous and that there is no a right answer.

This questionnaire will be used only for research purposes, so we ask you to be honest when answering the questions.

Considering your situation in the past 12 months:

The possible answers are:

a. Never

b. Once or twice

c. Sometimes

d. Often

1. Have you ever been concerned with gambling(e.g.,regarding past gambling experiences or thinking of ways of getting money with which you can gamble)?
2. Have you ever played increasing amounts of money in order to achieve enough excitement?
3. Have you ever made effort to control gambling?
4. Have you ever felt nervous when you try to control gambling?
5. Have you ever gambled in order to stop thinking about your personal problems?
6. After losing money, have you ever gambled to get even(chasingones losses)?
7. Have you ever lied regarding the time and the money spent gambling?
8. Has gambling ever negatively affected some personal relationships?
9. Have you ever relied on other people to compensate gambling losses?