# Gamblers or Investors? An Experiment on the Almost-Winning Outcome

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**Abstract**

Near-miss outcomes are real-life situations which increase the perceived probability of the occurrence of future successes. The Almost-Winning (AW) bias is the well-known cognitive bias that makes individuals unable to distinguish between situations in which near misses signal ability and situations in which near misses are completely meaningless, in the sense of being unrelated to future (likelihood of) winning. The empirical and neurological evidence shows that a near-miss increases gamblers' willingness to play: AW triggers a dopamine response similar to winning, in spite of no actual reward. Therefore, in a chance game, a sequence of AW outcomes easily generates an "irrational" willingness to continue playing, and might become a key factor in the development and maintenance of certain betting habits. We implement an experimental setting aimed at checking the relevance of the AW bias among ordinary students on order to evaluate its potential strength in absence of gambling pathologies. Two treatments are implemented in two different frames, an investment game (IG) and a slot machine game (SM), which try to avoid persistence at gaming.

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# 1 Introduction

Almost-Winning Outcomes (AW) are real-life situations which increase the perceived probability of the occurrence of future successes; however, when chance is binding, near-miss outcomes are completely meaningless, since they indicate nothing about the future likelihood of winning. The stemming cognitive bias makes individuals unable to distinguish between situations in which near misses signal ability and those in which no ability is involved.

This bias is part of the natural instinct when we face uncertain settings: Getting close to the goal increases the probability to achieve it in following trials. When gambling, the majority of people wrongly rely on previous events to predict future outcomes. Gamblers tend to create illusory links between independent events, forgetting or denying the exclusive randomness of the outcome.

Chase and Clark (2010) showed that near-miss outcomes (or almost winning) may elicit a dopamine response similar to winning, despite the fact that no actual reward is delivered. They found that in different games, near miss outcomes still activate parts of the brain associated with monetary wins and therefore increase individual willingness to play. This occurrence is highly relevant when we consider the fact that gambling is increasing in most developed countries, especially among young generations.

Previous empirical and theoretical research applies to compulsive gamblers, i.e., Benhsain et al. (2004), Camerer et al. (2004), Chase and Clark (2010), Cote et al. (2003), Coventry and Hudson (2001), Coulombe et al. (1992), Dixon et al. (2010), Griffiths (1994), Ladouceur et al. (1991), vanHolst et al. (2010): For those subjects strong evidence shows that near-misses are responsible in driving players to bet even though they keep losing. To the best of our knowledge little research has been devoted to near-miss effects on non-compulsive gamblers (Myrseth et al, 2010). Moreover, not many studies focus on the effect of AW outcomes on general decision making in other situations (such as management research, medicine and investment).[1]

Our focus is testing near-miss outcomes unrelated to pathological gambling: Individuals should recognize near-misses as meaningless signals in those situations that do not involve any degree of skill.

This study is based on an experimental study with multiple periods aimed at analyzing the almost winning bias through different information sets and decision-making contexts. We propose a simple chance game where subjects can decide which share of their initial endowment to allocate in a lottery: Thanks to our simple task, we are able to account for the effect of near-miss bias on their willingness to play (measured

[1] Near misses are seen as a possible distortion in decision making under risk and a miss opportunity of learning, Dillon and Tinsley (2008)

by the number of tokens allocated in the risky lottery).
We represent this chance game in two different framings: an investment game (IG) and a slot machine game (SM).[2] This is aimed to distinguish between the near-miss effect on players when they are facing a chance game framed as a gamble and a chance game framed as a financial market. Since almost winning triggers a different cognitive process and the statistical risk perception is distorted (Dillon and Tinsley, 2010), we want to check if changing the frame distorts the individual's perception of the game, and the underlying probabilities.[3] Moreover, individuals could have different arousal and sensation seeking depending on the framing in which the game is proposed (Anderson and Brown 1984, Ladouceur et al. 1991).

Two different information settings are implemented in order to understand how to decrease the number of erroneous perceptions by warning subjects on AW bias and independence of events or disclosing the actual winning probabilities (nudging versus awareness).[4]
Through this experimental setting, we add new insights in near-miss effects, through three levels of analysis. First, we identify overall a persistent effect of AW outcomes on next trials, showing that also non-compulsive gamblers might be affected by the same cognitive bias. Surprisingly, individuals who generally prefer to avoid risk are more responsive to AW outcomes. Second, we want to see if framing matters in perceiving AW bias: We find that near-misses are binding not only in a traditional gambling game, like the slot machine, but also in the investment game (there is no significant difference in the AW bias across frames). Third, we discuss the role of information in correcting the misinterpretation of AW outcomes. Both nudging and informing are effective in reducing the willingness to choose the risky choice. Probability information even helps people to correctly interpret the game and the AW bias tends to disappear.
The paper is organized as follows: Section 2 describes the experimental protocol; descriptive and statistical data analysis is presented in Section 3, including a last Section of robustness check; final remarks and guidelines for future research are proposed in Section 4.

[2]We define a chance game as a game where no skill or ability can help individuals to correctly forecast the future outcome, think of a slot machine or picking a lottery number. Thus, our work focuses on the individual representation of the near-miss outcomes in chance situations, where there is no possibility for the individual to affect the game result.

[3]We think that also noise traders face the financial market as a lottery.

[4]Occasional gamblers show that reminders about independence of events decrease the number of erroneous perceptions (Benhsain et al. (2004)) and the motivation to pursue the game is weaker among participants who were reminded.

## 2 Experimental Protocol

We ran seven sessions with a total of 144 students [5], recruited among the undergraduate population of Luiss University of Rome using Orsee (Greiner, 2004), at the laboratory Cesare. All experimental sessions, based on three stages and a questionnaire, are fully computerized using z-Tree (Fischbacher 2007).[6] In each experimental session there are two stages with 20 rounds each, in which the subjects face the basic task (Stage 1 and Stage 2 differ on the basis of the information provided to subjects, as it will be explained in section 2.3). Stage 3 proposes the Holt and Laury's (2002) protocol to elicit individual risk attitude.

We run this game proposing two different frames in order to detect if the occurrence of AW situations was more likely to affect experimental subjects when the same probabilistic decisions are framed as a chance game or as a skill game: Investment Game framing and the Slot Machine framing (IG and SM hereafter). Even if both framings reproduced the same chance environment, they differ in the way in which the decision task was presented.

For each round of the basic task, proposed in Stage 1 and Stage 2, participants decide how to allocate their endowment in a risky choice. In particular, in each round, participants decide how much to allocate of the initial endowment of 10 ECU (Experimental Currency Unit, with a conversion rate 1 ECU=€0.5) between a safe choice (keeping the money) and a risky choice. The risky choice is represented by a lottery with two possible outcomes, depending on the state of the world (respectively the good state, $S_G$ and the bad state, $S_B$). The probability of the good state ($S_G$) is $p_h$: when the good state occurs, the outcome consists of the amount of experimental units bet in the risky option times a positive marginal return (the marginal rate of return in the good state is $h$, where $h > 1$) which gives more than the initial investment. In the bad state ($S_B$) (which occurs with probability $p_l$) individuals receive back their bet in the risky option times a low marginal rate of return (we name it in the bad state $l$ where $l < 1$). The entire endowment ($e$) has to be allocated between the risky option ($x_1$) and the amount kept ($x_0$), which is characterized by a marginal rate of return equal to 1. In this sense the final payoff of each round is:

$$v(x_1) = \begin{cases} lx_1 + x_0 & \text{if } S_G \text{ occurs} \\ hx_1 + x_0 & \text{if } S_B \text{ occurs} \end{cases} \tag{1}$$

[5]We ran five sessions with 24 participants each and two sessions with 12 subjects only.

[6]The experiment is based on different treatments and framings in order to disentangle the almost winning effect from other effects. In this sense, a different set of instructions was provided to participants. English translation is reported in Appendix A, dataset and analysis are available upon request.

Where $x_0 = e - x_1$ and $h$ ($l$) is the marginal return of investing from the good (bad) state. We impose $p_h, p_l, h, l$ such that it is always optimal not to invest in the risky option for a risk-neutral individual, in particular every time this condition holds $p_h < \frac{1-l}{h-l}$ (the maximization problem is solved in Appendix B).

The result of each round is represented on the computer by a sequential set of images reproducing the occurrence of bad or good state. Images differ depending on the frame of the experimental session (see Instructions Appendix A). After each round, payoff is calculated and privately communicated to the participants.

To ensure the financial salience of each decision, only one period per stage was randomly selected at the end of the experiment for payment (with no additional show-up fee). The final result from the experiment was communicated at the end of Stage 3: The computer randomly selected one round from each stage and computed the final payment. After answering the final questionnaire, subjects were individually paid.

## 2.1 Investment Game Framing (IG)

The IG frame proposes a game in which individuals choose how much to invest a given endowment $e$ in a risky set of three assets. The risky option is an exchange-traded fund (ETF) that tracks a basket of assets related to three different (independent) markets: Microlift, Chip Corporation and Doltech. The good state ($S_G$), that is the winning state, is verified when all three markets present a bullish trend with probability $p_h = \frac{1}{8}$. The bad state ($S_B$) occurs when the outcome has at least one bear market with probability $p_l = \frac{7}{8}$. We set the marginal return in the good state $h = 3$ and the marginal return in the bad state $l = 0.1$.

In each round a scroll bar allows subjects to examine the 11 possible integer allocations (investing from 0 to 10 ECU in the risky asset) before taking their decision; for each potential investment the computer shows on the screen the possible result in terms of expected payoff, i.e. the potential earnings in the good and bad state. Once subjects made their investing decision, the computer selects the outcome of the three markets: the outcome of each of them will appear sequentially on screen (either a green arrow pointing up or a red arrow pointing down first for market Microlift, then Chip Corporation market and last for Doltech market).

We define the Almost Winning (AW hereafter) outcome when the first two markets are bullish, but not the third one. Other sequences of AW drawn, which include just one market bearing, might be included in the analysis; however, given the result is shown sequentially, it is reasonable to think that the dopamine rises while the first two markets are bullish and only the last one has a different trend, so we focus only on that sequence.

## 2.2 The Slot Machine Game Framing (SM)

The SM game proposes a game where individuals choose how much to bet of a given endowment $e$ on a Slot Machine line with three cells. The risky option is represented by random draws of different icons representing fruit and "BAR" symbol. The good state ($S_G$), that is the winning outcome, occurs when 3 "BAR" symbols appear on the subject's screen with probability $p_h = \frac{1}{8}$. The bad state ($S_B$) occurs when at least one symbol drawn from the slot machine is different from "BAR" with probability $p_l = \frac{7}{8}$. We set the marginal return in the good state $h = 3$ and the marginal return in the bad state $l = 0.1$.
In each round, participants can decide how many ECU to bet on the slot machine, given their initial endowment of 10 ECU, and how much they prefer to keep. A scroll bar allows the individual to examine the 11 possible bets and for each potential bet the possible earnings in the good and the bad state. Then the slot machine appears, rolling three different images, and sequentially the cells stop to one symbol. We define the AW when "BAR" occurs in the first two cells, but not in the last one. Each round works as described in Section 2.1 and it is characterized by the same steps and layout.

## 2.3 Information on Almost-Winning

Each treatment (IG and SM) is divided by stages. In particular, Stage 1 is common to all sessions: After explaining the game structure, individuals played 20 rounds without any disclosure on probabilities or additional game rules.[7]
At the end of Stage 1 we elicit the probability beliefs of participants by asking them to guess the probability of winning among several options. Stage 2 differs from the first one in the following way:

1. **Stage 2A** in which individuals were informed on the probability of the good state, which is $p_h = \frac{1}{8}$. We call this stage the "Probability Stage."

2. **Stage 2B** in which individuals were informed about the possible effect of almost-winning outcomes, underlying the independence of each round played.

[7] Even if participants could ask questions individually to the experimenter after reading the instructions, very few of them asked about the probability of winning and the experimenter was trained not to provide this kind of information at that stage.

Table 1: Experimental Structure

| | Session | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1[1] | 2 | 3[1] | 4 | 5 | 6 | 7 |
| Average Payment | 15.10 | 9.05 | 16.93 | 12.00 | 10.46 | 13.95 | 12.55 |
| Number of subjects | 24 | 24 | 24 | 12 | 24 | 12 | 24 |
| | Framing | | | | | | |
| IG framing | x | x | x | | | x | x |
| SM framing | | | | x | x | | |
| | Stage 1 (20 rounds) | | | | | | |
| No Information | x | x | x | x | x | x | x |
| | Stage 2 (20 rounds) | | | | | | |
| Probability (2A) | x | | x | | x | | x |
| Warning (2B) | | x | | x | | x | |
| | Stage 3 (30 rounds) | | | | | | |
| Holt and Laury's protcol | x | x | x | x | x | x | x |
| | AW | | | | | | |
| Forced AW | | | | x | x | x | x |

**Notes**: Experiment structure for each session.
[1] These two sessions included an extra task at the end of the experiment, which is not analyzed in this work and did not affect the results of the first stages.

We call this stage the "Warning Stage."[8]

In Stage 3, equal for all sessions, subjects play the well known Holt and Laury (2002) lottery protocol to control for individual risk aversion.
A questionnaire collects additional information about our subjects at the end of the experiment.

Since the actual random occurrence of AW could be poorly informative from our research point of view, we adopted different frequencies of almost winning: One generated randomly by the software (in this case probability of a random almost winning is $p_{AW} = \frac{1}{8}$ given three cells with probability of good state one half each) or forced such that the probability of almost winning is, at least, $p_{AW} = \frac{3}{8}$ while the probability of winning is kept constant $p_h = \frac{1}{8}$. Regardless the almost winning frequency, instructions did not change since the other salient information we provided was the winning probability in Stage 2A. To summarize the experimental protocol, see Table 1.

[8]At the beginning of the both stages a message appeared on the screen. In the probability stage, the message simply states "Note that the probability of three bullish markets (three bars) is $\frac{1}{8}$ ". In the warning stage the message at the beginning of the session states "Note that, if you nearly win in the previous round, i.e. two bullish markets (two bars), it does not have any effect on the winning probability in future rounds "

# 3 Results

In this section we present the main results focusing on different levels of analysis. In Section 3.1 we start describing the variables collected through the experiment. Section 3.2 is based on the analysis of the AW and framing biases, underlying the role of risk preferences. The second step investigates the role of information, in particular whether informing on probabilities or nudging is more relevant to weaken the AW effect (Section 3.3). We conclude with robustness checks without relying on distributional assumptions, based on bootstrap procedure, Section 3.4.

## 3.1 Descriptive Analysis

Table 2: Tokens allocated in the risky choice

| **Investment differences by Stages** | | | |
|---|---|---|---|
| | Average investment | | |
| | **Stage 1** | **Stage 2A, Probability** | **Stage 2B, Warning** |
| Tokens allocated after an AW round | 2.47 | 1.53 | 1.85 |
| | (1831) | (1257) | (616) |
| Tokens allocated in other rounds | 2.40 | 1.50 | 1.26 |
| | (905) | (567) | (296) |
| WRT | *0.11* | *0.01* | *0.00* |
| Random AW[1] | 2.50 | 1.66 | 1.22 |
| | (1440) | (960) | (480) |
| Forced AW[1] | 2.93 | 1.59 | 2.05 |
| | (720) | (480) | (240) |
| WRT | *0.00* | *0.18* | *0.01* |
| SM[2] | 1.99 | 1.08 | 1.66 |
| | (720) | (480) | (240) |
| IG[2] | 2.93 | 1.59 | 2.05 |
| | (720) | (480) | (240) |
| WRT | *0.00* | *0.90* | *0.81* |
| | Individual characteristics | | |
| Man | 2.42 | 1.46 | 1.53 |
| | (1820) | (1220) | (600) |
| Women | 2.58 | 1.58 | 1.55 |
| | (1060) | (700) | (360) |
| WRT: | *0.00* | *0.02* | *0.69* |
| Self evaluation on math capabilities: lower than average | 3.23 | 1.41 | 3.46 |
| | (300) | (200) | (100) |
| Self evaluation on math capabilities: average | 2.66 | 1.75 | 1.48 |
| | (1920) | (1220) | (700) |
| Self evaluation on math capabilities: higher than average | 1.61 | 0.92 | 0.59 |
| | (660) | (500) | (160) |
| WRT: Low vs. Average | *0.00* | *0.20* | *0.00* |
| WRT: Average vs. High | *0.00* | *0.00* | *0.00* |
| Do you like betting: no | 2.31 | 1.35 | 1.51 |
| | (1680) | (1160) | (520) |
| Do you like betting: yes | 2.72 | 1.74 | 1.57 |
| | (1200) | (760) | (440) |
| WRT | *0.05* | *0.50* | *0.49* |

**Notes**: All tests reported are two-sided Wilcoxon Rank Sum Test (WRT). In parenthesis the number of observations.
[1] comparison between investment game with and without forced almost winning.
[2] We compare the Slot Machine Game and the Investment Game with forced AW outcomes.

Table 2 summarizes the findings related to tokens allocation differences by game rules and individual characteristics across stages. When we consider the first stage, the allocation of tokens is not significantly different when we compare rounds right

after AW outcomes and those in which it didn't occur, although AW frequency is significantly relevant: When we force the frequency of AW, participants played significantly more. AW outcomes increase the average allocation of tokens to the risky choice and when this is more frequent it is associated to higher willingness to play, consistent with Cote et al. (2003) results.
We observe a significant difference between individuals playing the slot machine and the investment game framing. On average, subjects invest more in IG framing rather than betting on the classic slot machine.[9] When we control for elicited beliefs on probability (the winning probability they guessed at the end of Stage 1 when AW is more frequent) we find that there is no difference across framings and treatments, as shown in Table 9 in Appendix C.

When we look at individual characteristics we find that female subjects tend to invest on average significantly more, as well as participants with lower math skills and those who enjoy more to gamble.

When we control for the following stages, we find very similar results, although we want to underline some interesting exceptions which can lead our regression analysis. In Stage 2A, probability knowledge provokes a severe drop in tokens allocated to the risky option, in particular when AW frequency was forced. Stage 2B is consistent to observations made for Stage 1. Awareness on winning probability and larger experience reduce the amount gambled in both framings,showing that subjects seem to be able to evaluate the actual probabilities of winning.

The tokens allocated in the risky option increase when individuals are more inclined to risk. The sample is quite heterogeneous, risk-seeking individuals (46.53% of the total sample) tend to allocate an average of 2.67 tokens to the risky choice, which is higher compared to the average tokens allocated by risk-neutral individuals (18.06% of the total sample allocates just an average of 1.68 tokens to the risky option), and those showing risk averse preferences (35.42%) allocate only 1.25 tokens on average.

The individual decision on tokens allocation in Stage 1 is analyzed in Table 3 looking at the risk attitude. Risk averse individuals invest significantly more in the risky choice after an AW outcome and in those sessions where AW was more frequent, while instead risk-seeking individuals are consistent on their investment choice regardless the occurrence and frequency of AW outcomes.

On the other hand, risk seeking individuals invest significantly more in the IG framing than betting in the SM one: Individuals showing risk aversion are more consistent across framings.

[9] We test the framing differences just with the sessions with forced almost winning, however, replicating the test and including also the IG with no forced AW, the difference of tokens allocation holds: Tokens allocated in the risky choice are greater in the investment game than the slot machine, regardless the AW frequency.

Table 3: Tokens allocated in Stage 1 by risk averse/neutral/seeking individuals

| | Average tokens allocation in Stage 1 | | | | |
|---|---|---|---|---|---|
| | Risk Averse | Risk Neutral | Risk Seeking | Wilcoxon rank-sum (R. Averse vs.Neutral) | Wilcoxon rank-sum (R. Neutral vs. Seeking) |
| Tokens allocated after an AW round | 1.76 | 2.32 | 3.12 | *0.00* | *0.08* |
| | (319) | (186) | (400) | | |
| Tokens allocated in other rounds | 1.56 | 1.90 | 3.20 | *0.00* | *0.00* |
| | (650) | (308) | (873) | | |
| WRT | *0.01* | *0.02* | *0.77* | | |
| Random AW[1] | 1.66 | 1.82 | 3.44 | *0.01* | *0.00* |
| | (580) | (200) | (660) | | |
| Forced AW[1] | 2.17 | 2.20 | 3.53 | *0.96* | *0.00* |
| | (200) | (120) | (400) | | |
| WRT | *0.00* | *0.63* | *0.33* | | |
| SM[2] | 1.42 | 2.22 | 2.31 | *0.00* | *0.07* |
| | (240) | (200) | (280) | | |
| IG[2] | 2.17 | 2.20 | 3.53 | *0.96* | *0.00* |
| | (200) | (120) | (400) | | |
| WRT | *0.30* | *0.06* | *0.00* | | |
| Man | 1.72 | 2.09 | 3.18 | *0.00* | *0.00* |
| | (700) | (340) | (780) | | |
| Women | 1.67 | 1.99 | 3.30 | *0.02* | *0.00* |
| | (320) | (180) | (560) | | |
| WRT | *0.40* | *0.96* | *0.02* | | |
| Self evaluation on math capabilities: lower than average | 1.08 | 2.38 | 4.23 | *0.00* | *0.00* |
| | (60) | (60) | (180) | | |
| Self evaluation on math capabilities: average | 2.01 | 2.47 | 3.19 | *0.00* | *0.01* |
| | (660) | (340) | (920) | | |
| Self evaluation on math capabilities: higher than average | 1.17 | 0.73 | 2.61 | *0.14* | *0.00* |
| | (300) | (120) | (240) | | |
| WRT: Low vs. Average | *0.04* | *0.64* | *0.00* | | |
| WRT: Average vs. High | *0.00* | *0.00* | *0.00* | | |
| Do you like betting: no | 1.50 | 2.15 | 2.99 | *0.00* | *0.00* |
| | (600) | (300) | (780) | | |
| Do you like betting: yes | 2.00 | 1.93 | 3.57 | *0.21* | *0.00* |
| | (420) | (220) | (560) | | |
| WRT | *0.04* | *0.22* | *0.03* | | |

**Notes**: Risk preferences were inferred by the Holt and Laury's lotteries chosen in the third session of the experiment. All tests reported are two-sided Wilcoxon Rank Sum Test (WRT). In parenthesis the number of observations.
[1] comparison between investment game with and without forced almost winning.
[2] We compare the Slot Machine Game and the Investment Game whit forced AW outcomes.

Table 3 considers also the individual characteristics which we include as controls in our analysis: Females and males showing risk averse attitude allocate a similar amount of tokens to the risky option, while females showing risk-loving preferences are more willing to play riskier than male participants. Risk-loving individuals who poorly self evaluate their math skills tend to play significantly more. Enjoyment of gambling rises significantly with the average allocation of tokens to the risky option regardless of risk preferences.

These results are stressing the importance of risk preferences in this experiment, in particular risk attitude weakens or strengthens different cognitive bias provided by our experimental setting.

When we look at the individual allocation across stages and periods (Appendix C, Figure 9 - Figure 14) risk-averse subjects are characterized by a smoother-path, tending to zero token allocation to the risky choice, while positive investment to the risky option is more frequent when individuals are risk seeking. This result does confirm that risk lovers play more than the risk averse although it does not clarify who is more likely to be affected by AW outcomes.

## 3.2 AW Effect and Framing Effect

The descriptive analysis pointed out unexpected differences in tokens allocation when we consider risk preferences and that subjects tend to gamble more when they face the IG framing. The analysis focuses on both effects in particular the relationship between the allocation of tokens in the risky option in each round and the almost-winning outcome in previous rounds, controlling by possible framing and individual characteristics. We focus on the analysis of the first stage, where individuals have the same information. In particular, we implement the basic model:

$$y_{it} = \alpha + \beta_1 aw_{it-1} + \beta_2 ig_i + \beta_3 t_{it} + \gamma' X_{it-1} + \delta' Z_i + u_i + \varepsilon_{it} \quad (2)$$

$i = 1, ..., 144,\ t = 2, ..., 20$

Where $y_{it}$ is the amount of tokens allocated to the risky option, $aw_{it-1}$ is a dummy variable equal to 1 when AW outcome occurred in the previous period, while $ig$ is the dummy referring to the investment game. We control for the period $t$ and $X_{it-1}$, the outcome in the previous round associated to winning trials. Finally, we include some individual controls, such as gender, risk preferences, betting pleasure and self evaluation on math capabilities.

Table 4 collects the results of five specifications with an increasing number of control variables. In specification (1) and (2) we consider only the AW, framing effect and time: Tokens allocation is significantly decreasing through time and positively related to almost winning outcomes: in particular seeing an AW increase of 0.5 for the average allocation to the risky option. IG framing coefficient is positive although not significant. Controlling for past outcomes and individual characteristics (model (3) and (4)) weaken the effect of AW but it remains positive on investment of the next round: Rather than simple multicollinearity between exogenous variables, we might focus on possible heterogeneity among individuals. Specification (5) of Table 4 checks the interaction between AW outcomes and framing effect with respect to the benchmark, the lagged AW outcome in IG framing: We conclude that AW outcomes are equally perceived in both framings, and significantly higher compared to lagged period without AW in the IG framing.

If the AW outcomes affect the pool of individuals recruited for this experiment which is not strictly related to compulsive behavior in gambling, we might claim that individuals are willing to play more when they see AW outcomes regardless of compulsiveness. Experience decreases the tokens allocated in the risky option while it is positively related to interaction between winning periods and payoff which means

Table 4: Almost Winning effect on token's allocation in Stage 1

| | Token allocation in risky choice, Stage 1 | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) |
| L.AW | 0.50*** | 0.52*** | 0.31* | 0.31 | |
| | (0.19) | (0.19) | (0.19) | (0.19) | |
| Tr IG | | 0.92 | 0.45 | 0.50 | |
| | | (0.78) | (0.64) | (0.63) | |
| TrSM*L.AW=0 | | | | | -0.73 |
| | | | | | (0.68) |
| TrIG*L.AW=0 | | | | | -0.49** |
| | | | | | (0.23) |
| TrSM*L.AW=1 | | | | | -0.80 |
| | | | | | (0.67) |
| Round | -0.15*** | -0.15*** | -0.12*** | -0.12*** | -0.12*** |
| | (0.01) | (0.01) | (0.01) | (0.01) | (0.01) |
| L.Winning * L.Payoff | | | 0.40*** | 0.40*** | 0.40*** |
| | | | (0.06) | (0.06) | (0.06) |
| L.Winning | | | -4.24*** | -4.23*** | -4.27*** |
| | | | (0.82) | (0.82) | (0.82) |
| L.Payoff | | | -0.34*** | -0.34*** | -0.34*** |
| | | | (0.04) | (0.04) | (0.04) |
| Risk[1] | | | 0.42*** | 0.35*** | 0.35*** |
| | | | (0.12) | (0.12) | (0.12) |
| Female | | | | -0.00 | 0.00 |
| | | | | (0.57) | (0.57) |
| Self evaluation on math capabilities[2] | | | | -1.61*** | -1.61*** |
| | | | | (0.49) | (0.49) |
| Do you like betting?[3] | | | | 0.78 | 0.78 |
| | | | | (0.56) | (0.56) |
| Constant | 2.36*** | 1.66** | 1.97** | 4.65*** | 5.59*** |
| | (0.38) | (0.70) | (0.99) | (1.57) | (1.63) |
| Constant($\sigma_u$) | 3.93*** | 3.91*** | 3.14*** | 3.01*** | 3.01*** |
| | (0.27) | (0.27) | (0.24) | (0.23) | (0.23) |
| Constant ($\sigma_e$) | 3.60*** | 3.60*** | 3.54*** | 3.54*** | 3.54*** |
| | (0.08) | (0.08) | (0.07) | (0.07) | (0.07) |
| Observations | 2736 | 2736 | 2736 | 2736 | 2736 |
| $\rho$ | 0.54 | 0.54 | 0.44 | 0.42 | 0.42 |
| $N_{lc}$ | 1126 | 1126 | 1126 | 1126 | 1126 |
| $N_{rc}$ | 183 | 183 | 183 | 183 | 183 |
| $\sigma_e$ | 3.60 | 3.60 | 3.54 | 3.54 | 3.54 |
| $\sigma_u$ | 3.93 | 3.91 | 3.14 | 3.01 | 3.01 |

**Notes**: Panel tobit regressions with random effects, censored at 0 and 10. Stage 1 from all sessions are included in this analysis.
[1] The risk is measured from 0 (max. risk averse) to 10 (max. risk lover).
[2] In the questionnaire we asked "How do you consider your math capabilities?" The answers were Lower than Average (10.42 %), On Average (66.67%), Higher than the Average (22.92%)
[3] Dummy variable for Yes and No, in the questionnaire we asked "Do you like to bet?"
(* 0.1, ** 0.05, *** 0.01)

that winning tokens through risky option increases the willingness to play. Risk increases betting and is consistent to the analysis carried before, but the framing effect underlined in previous analysis is not significant. Table 4 includes some individual characteristics: Gender is not a relevant variable, instead the self statement on math capabilities is negatively correlated with playing more on the risky option.

It is reasonable to think that subjects have different perceptions toward AW outcomes: Some of them could be more affected. We have individuals who prefer to adopt a safe strategy and to allocate zero tokens to the risky option, and others enjoying the possibility to bet constantly some positive amount. Our previous results already cast some light on differences among these two groups, and a big role is played by risk attitude. On the other hand, descriptive analysis pointed out that risk averse individuals are more likely to increase their bet after seeing the AW outcome

Table 5: Almost-Winning effect on token's allocation in Stage 1, by risk preferences

| | Token allocation in risky choice, Stage 1 | | | | | |
|---|---|---|---|---|---|---|
| | Risk Averse | | | Risk Neutral+Risk Seeking | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | β/(se) | β/(se) | β/(se) | β/(se) | β/(se) | β/(se) |
| L.AW | 0.75** | 0.55* | | 0.38* | 0.17 | |
| | (0.31) | (0.31) | | (0.23) | (0.24) | |
| Tr IG | | -1.10 | | | 1.25 | |
| | | (1.11) | | | (0.77) | |
| TrSM*L.AW=0 | | | 0.62 | | | -1.34 |
| | | | (1.18) | | | (0.83) |
| TrIG*L.AW=0 | | | -0.73* | | | -0.37 |
| | | | (0.38) | | | (0.28) |
| TrSM*L.AW=1 | | | 0.84 | | | -1.60** |
| | | | (1.15) | | | (0.81) |
| Round | -0.18*** | -0.12*** | -0.12*** | -0.14*** | -0.12*** | -0.12*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| L.Winning * L.Payoff | | 0.79*** | 0.79*** | | 0.27*** | 0.27*** |
| | | (0.12) | (0.12) | | (0.07) | (0.07) |
| L.Winning | | -8.52*** | -8.57*** | | -2.81*** | -2.84*** |
| | | (1.51) | (1.51) | | (0.99) | (0.99) |
| L.Payoff | | -0.52*** | -0.51*** | | -0.28*** | -0.28*** |
| | | (0.07) | (0.07) | | (0.05) | (0.05) |
| Female | | 0.32 | 0.32 | | 0.04 | 0.04 |
| | | (0.92) | (0.92) | | (0.69) | (0.69) |
| Self evaluation on math capabilitie[1] s | | -0.85 | -0.85 | | -1.89*** | -1.89*** |
| | | (0.76) | (0.76) | | (0.61) | (0.61) |
| Do you like betting?[2] | | 1.71* | 1.72* | | 0.65 | 0.65 |
| | | (0.98) | (0.98) | | (0.68) | (0.69) |
| Constant | 1.11* | 5.31** | 4.87* | 3.10*** | 7.18*** | 8.74*** |
| | (0.61) | (2.16) | (2.52) | (0.45) | (1.66) | (1.62) |
| Constant ($\sigma_u$) | 3.71*** | 2.67*** | 2.67*** | 3.74*** | 3.03*** | 3.03*** |
| | (0.45) | (0.36) | (0.36) | (0.32) | (0.28) | (0.28) |
| Constant ($\sigma_e$) | 3.31*** | 3.21*** | 3.21*** | 3.71*** | 3.66*** | 3.65*** |
| | (0.13) | (0.12) | (0.12) | (0.09) | (0.09) | (0.09) |
| Observations | 969 | 969 | 969 | 1767 | 1767 | 1767 |
| $\rho$ | 0.56 | 0.41 | 0.41 | 0.50 | 0.41 | 0.41 |
| $N_{lc}$ | 502.00 | 502.00 | 502.00 | 624.00 | 624.00 | 624.00 |
| $N_{rc}$ | 42.00 | 42.00 | 42.00 | 141.00 | 141.00 | 141.00 |
| $\sigma_e$ | 3.31 | 3.21 | 3.21 | 3.71 | 3.66 | 3.65 |
| $\sigma_u$ | 3.71 | 2.67 | 2.67 | 3.74 | 3.03 | 3.03 |

**Notes**: Panel tobit regressions with random effects, censored at 0 and 10. Stage 1 from all sessions are included in this analysis.
[1] In the questionnaire we asked "How do you consider your math capabilities?" The answers were Lower than Average (10.42 %), On Average (66.67%), Higher than the Average (22.92%)
[2] Dummy variable for Yes and No, in the questionnaire we asked "Do you like to bet?"
(* 0.1, ** 0.05, *** 0.01)

(see Table 3)

When we carry the analysis dividing the sample in groups with different risk attitude, the AW effect is significantly relevant only for risk-averse individuals (see Table 5). Subjects showing risk aversion are consistent to the analysis made: Their investment in the risky option significantly decreases over time, while lagged payoffs have a positive effect when interacted with winning rounds. Those who enjoy betting are indeed playing more, and framing effect does not play any role. AW bias is significant regardless of the specification adopted, and when we look at the interaction between AW and treatment, it becomes clear that the AW effect is particularly relevant when we consider the investment game.[10]

Risk-seeking and neutral agents prefer to bet no matter what: Even though AW

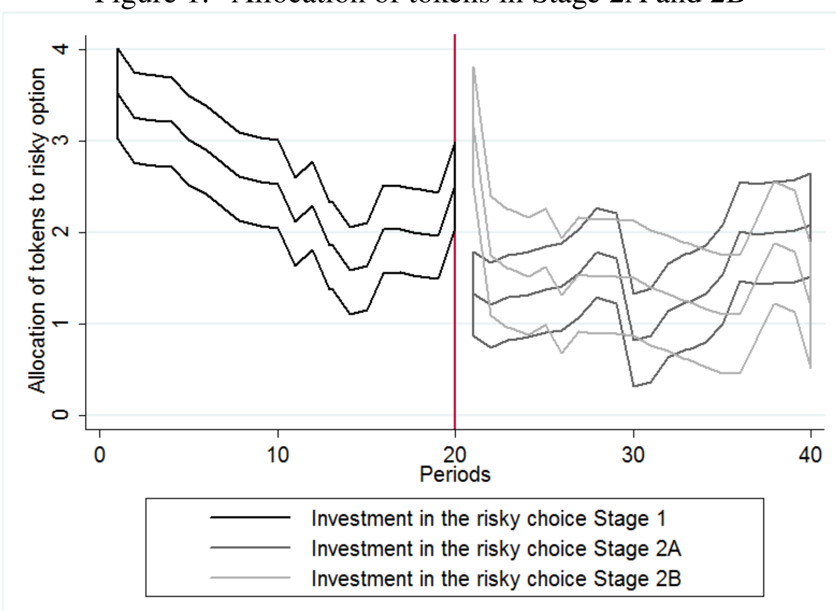
[10] Tokens allocated in the slot machine after an AW outcome is not significantly different from the other rounds.

bias is positive and significant in some specifications, the magnitude of the effect is significantly smaller compared to the effect shown for risk-averse individuals. Framing is not significant but when we check on the interaction between framing and almost winning, we noticed that AW in investment game has a much stronger effect than the AW bias in a slot machine game. Individuals do not invest significantly more by framing, but AW bias could be more often misinterpreted in such context. Although self evaluation on math capabilities is irrelevant for risk-averse individuals, when we consider risk-neutral and risk-seeking ones, it becomes negatively (and significantly) related to tokens bet.

### 3.3 Warning or Nudging: This Is The Question

The second stage of both treatments is aimed to check how people are changing their gambling choices. Results from the first stage points out the role of risk attitude in reacting to AW cognitive bias; the second stage should help subjects to correctly interpret the game and the meaning of AW outcomes.

Figure 1: Allocation of tokens in Stage 2A and 2B




**Notes**: Kernel-weighted local polynomial smoothing with CI.

From the policy-maker perspective, results discussed in Section3.2 stress the role of risk attitude on the kind of "player"wrongly perceiving the AW bias. AW outcomes are tricks which promote a riskier behavior for those individuals which naturally prefer not to gamble.

The second stage is aimed to find the more effective way to help agents to correctly interpret the role of AW biases: We discuss the persistence in playing, but we are mainly interested if the AW bias is weakened by different information. Individuals were either informed about probabilities of winning or about the cognitive bias lying behind the AW outcome. We are basically investigating how individuals change their approach when either informed or nudged.

Figure 1 can help to understand the average tokens allocation after information: Individuals knowing winning probabilities allocates significantly less tokens than the others. In Stage 2A, knowing the winning probability reduces suddenly the betting level; they review their winning expectations and decide to minimize their tokens allocation to the risky option (also the optimal solution of this game, discussed in Appendix B). After a first moment of disappointment, last periods of the Stage 2A are characterized by an increase in tokens allocated to the risky option.

Players from Stage 2B, instead, are decreasing their bets smoothly. Last periods of both stages are characterized by end game effect where individuals increase significantly the token allocation to the risky option.

Table 6 represents the average investment through Stage 2A and Stage 2B. The results are underlying that informing individuals on independence between rounds is not sufficient to minimize the AW bias, while probabilities seem to have a stronger effect and individuals are less sensitive to AW bias. In Stage 2B, even though subjects adapt through experience lowering their investment in the risky choice, we show that warning per se is not very effective.

In Stage 2A, tokens allocation to the risky choice significant increases through time (the effect is not linear, as we saw in Figure 1, but the overall effect is driven by the increasing tokens allocation in the risky choices of last rounds); risk preferences are still playing a (positive) role as well as past outcomes. In Stage 2B risk preferences and time are not relevant, while higher math capabilities lower the willingness to play, even more sharply than what observed in Stage 1.

Finally, Table 7 distinguishes between risk averse and the others (we jointly consider risk-neutral and risk-seeking) in order to check which information was more relevant among stages and risk preferences.

AW outcomes are weakly affecting individual's choices. Participants informed on winning probabilities in Stage 2A, regardless their risk attitude, are immune to AW bias in particular they tend to play even more safely in the investment game framing. Informing them on the market probabilities shows them the real nature of the investment game, just related with luck rather than knowledge on financial market.

## Table 6: Almost-Winning effect on token's allocation in Stage 2A and 2B

| | Token allocation in risky choice, Stage 2 and Stage 3 | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) |
| L.AW | 0.53* | 0.05 | | 0.50** | 0.54** | |
| | (0.29) | (0.28) | | (0.24) | (0.26) | |
| Tr IG | | -0.54 | | | 0.38 | |
| | | (0.87) | | | (1.31) | |
| TrSM*L.AW=0 | | | 0.50 | | | -0.93 |
| | | | (0.94) | | | (1.35) |
| TrIG*L.AW=0 | | | -0.20 | | | -0.51* |
| | | | (0.34) | | | (0.31) |
| TrSM*L.AW=1 | | | 0.30 | | | -0.33 |
| | | | (0.93) | | | (1.34) |
| Round | 0.09*** | 0.06*** | 0.06*** | -0.04** | -0.03 | -0.03 |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| L.Winning * L.Payoff | | 0.64*** | 0.65*** | | 0.27** | 0.27** |
| | | (0.09) | (0.09) | | (0.11) | (0.11) |
| L.Winning | | -6.98*** | -7.01*** | | -2.34* | -2.33* |
| | | (1.13) | (1.13) | | (1.30) | (1.30) |
| L.Payoff | | -0.67*** | -0.67*** | | -0.24*** | -0.24*** |
| | | (0.06) | (0.06) | | (0.07) | (0.07) |
| Risk[1] | | 0.60*** | 0.60*** | | 0.11 | 0.11 |
| | | (0.19) | (0.19) | | (0.21) | (0.21) |
| Gender | | -0.32 | -0.32 | | -0.23 | -0.23 |
| | | (0.80) | (0.80) | | (1.13) | (1.13) |
| Self evaluation on math capabilities[2] | | -1.17* | -1.17* | | -3.41*** | -3.41*** |
| | | (0.67) | (0.67) | | (1.05) | (1.05) |
| Do you like betting?[3] | | 0.20 | 0.21 | | 0.17 | 0.17 |
| | | (0.79) | (0.79) | | (1.14) | (1.14) |
| Constant | -3.23*** | 2.60 | 2.23 | -0.77 | 7.17** | 8.07** |
| | (0.62) | (2.36) | (2.38) | (0.68) | (2.93) | (3.32) |
| Constant($\sigma_u$) | 4.96*** | 3.41*** | 3.40*** | 4.16*** | 3.27*** | 3.27*** |
| | (0.47) | (0.35) | (0.35) | (0.56) | (0.46) | (0.46) |
| Constant($\sigma_e$) | 3.92*** | 3.62*** | 3.62*** | 2.51*** | 2.49*** | 2.49*** |
| | (0.12) | (0.11) | (0.11) | (0.10) | (0.10) | (0.10) |
| Observations | 1824 | 1824 | 1824 | 912 | 912 | 912 |
| $\rho$ | 0.61 | 0.47 | 0.47 | 0.73 | 0.63 | 0.63 |
| $N_{lc}$ | 1101 | 1101 | 1101 | 488 | 488 | 488 |
| $N_{rc}$ | 71 | 71 | 71 | 18 | 18 | 18 |
| $\sigma_e$ | 3.92 | 3.62 | 3.62 | 2.51 | 2.49 | 2.49 |
| $\sigma_u$ | 4.96 | 3.41 | 3.40 | 4.16 | 3.27 | 3.27 |

**Notes**: Panel tobit regressions with random effects, censored at 0 and 10. Stage 1 from all sessions are included in this analysis.
[1] The risk is measured from 0 (max. risk averse) to 10 (max. risk lover).
[2] In the questionnaire we asked "How do you consider your math capabilities?" The answers were Lower than Average (10.42 %), On Average (66.67%), Higher than the Average (22.92%)
[3] Dummy variable for Yes and No, in the questionnaire we asked "Do you like to bet?"
(* 0.1, ** 0.05, *** 0.01)

## Table 7: Almost-Winning effect on token's allocation in Stage 2A and 2B, by risk preferences

| | Token allocation in risky choice, Stage 2 and Stage 3 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stage 2A | | | | | | Stage 2B | | | | | |
| | Risk Averse | | | Others | | | Risk Averse | | | Others | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) |
| L.AW | 0.34 | -0.25 | | 0.54 | 0.18 | | 0.07 | 0.56 | | 0.76** | 0.55* | |
| | (0.52) | (0.46) | | (0.34) | (0.33) | | (0.38) | (0.40) | | (0.31) | (0.33) | |
| Tr IG | | -2.79* | | | 0.61 | | | 0.49 | | | 0.98 | |
| | | (1.46) | | | (1.04) | | | (2.27) | | | (1.47) | |
| TrSM*L.AW=0 | | | 2.93* | | | -0.74 | | | -1.19 | | | -1.46 |
| | | | (1.59) | | | (1.12) | | | (2.29) | | | (1.52) |
| TrIG*L.AW=0 | | | -0.04 | | | -0.31 | | | -0.23 | | | -0.71* |
| | | | (0.71) | | | (0.39) | | | (0.47) | | | (0.39) |
| TrSM*L.AW=1 | | | 2.49 | | | -0.83 | | | 0.10 | | | -1.23 |
| | | | (1.57) | | | (1.10) | | | (2.28) | | | (1.51) |
| Round | 0.16*** | 0.11*** | 0.11*** | 0.06** | 0.04 | 0.04 | -0.03 | -0.01 | -0.01 | -0.04 | -0.03 | -0.03 |
| | (0.04) | (0.03) | (0.03) | (0.03) | (0.02) | (0.02) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) | (0.03) |
| L.Winning * L.Payoff | | 0.62*** | 0.63*** | | 0.63*** | 0.63*** | | 0.70*** | 0.70*** | | 0.17 | 0.18 |
| | | (0.20) | (0.20) | | (0.10) | (0.10) | | (0.22) | (0.22) | | (0.13) | (0.13) |
| L.Winning | | -7.66*** | -7.69*** | | -6.34*** | -6.38*** | | -6.25** | -6.19** | | -2.48 | -2.54 |
| | | (2.28) | (2.29) | | (1.31) | (1.32) | | (2.62) | (2.60) | | (1.60) | (1.61) |
| L.Payoff | | -0.74*** | -0.74*** | | -0.66*** | -0.66*** | | -0.39*** | -0.40*** | | -0.14* | -0.15* |
| | | (0.13) | (0.13) | | (0.07) | (0.07) | | (0.11) | (0.11) | | (0.08) | (0.08) |
| Male | | 0.30 | 0.34 | | -0.07 | -0.08 | | -0.30 | -0.29 | | -0.76 | -0.73 |
| | | (1.32) | (1.32) | | (0.94) | (0.93) | | (1.63) | (1.61) | | (1.30) | (1.30) |
| Self evaluation on math capabilities[1] | | -1.42 | -1.41 | | -0.96 | -0.97 | | -1.62 | -1.60 | | -5.32*** | -5.30*** |
| | | (1.04) | (1.04) | | (0.80) | (0.80) | | (1.71) | (1.68) | | (1.26) | (1.26) |
| Do you like betting?[2] | | 2.00 | 2.02 | | -0.26 | -0.25 | | -0.96 | -0.95 | | 2.30* | 2.28* |
| | | (1.43) | (1.43) | | (0.93) | (0.92) | | (2.05) | (2.02) | | (1.29) | (1.29) |
| Constant | -5.59*** | 5.80** | 2.90 | -1.94*** | 6.41*** | 7.29*** | -1.73* | 6.11 | 6.96 | 0.08 | 8.48*** | 10.08*** |
| | (1.05) | (2.88) | (3.27) | (0.71) | (2.46) | (2.29) | (0.97) | (5.07) | (6.13) | (0.89) | (2.69) | (3.04) |
| Constant($\sigma_u$) | 4.16*** | 2.73*** | 2.74*** | 4.76*** | 3.45*** | 3.44*** | 3.69*** | 3.06*** | 3.01*** | 4.12*** | 2.79*** | 2.78*** |
| | (0.79) | (0.57) | (0.57) | (0.52) | (0.42) | (0.42) | (0.83) | (0.72) | (0.71) | (0.70) | (0.50) | (0.50) |
| Constant($\sigma_e$) | 3.18*** | 2.77*** | 2.77*** | 4.10*** | 3.82*** | 3.82*** | 2.41*** | 2.33*** | 2.32*** | 2.55*** | 2.53*** | 2.53*** |
| | (0.21) | (0.19) | (0.19) | (0.15) | (0.14) | (0.14) | (0.16) | (0.15) | (0.15) | (0.12) | (0.12) | (0.12) |
| Observations | 570 | 570 | 570 | 1254 | 1254 | 1254 | 399 | 399 | 399 | 513 | 513 | 513 |
| $\rho$ | 0.63 | 0.49 | 0.49 | 0.57 | 0.45 | 0.45 | 0.70 | 0.63 | 0.63 | 0.72 | 0.55 | 0.55 |
| $N_{lc}$ | 420.00 | 420.00 | 420.00 | 681.00 | 681.00 | 681.00 | 251.00 | 251.00 | 251.00 | 237.00 | 237.00 | 237.00 |
| $N_{rc}$ | 8.00 | 8.00 | 8.00 | 63.00 | 63.00 | 63.00 | 4.00 | 4.00 | 4.00 | 14.00 | 14.00 | 14.00 |
| $\sigma_e$ | 3.18 | 2.77 | 2.77 | 4.10 | 3.82 | 3.82 | 2.41 | 2.33 | 2.32 | 2.55 | 2.53 | 2.53 |
| $\sigma_u$ | 4.16 | 2.73 | 2.74 | 4.76 | 3.45 | 3.44 | 3.69 | 3.06 | 3.01 | 4.12 | 2.79 | 2.78 |

**Notes**: Panel tobit regressions with random effects, censored at 0 and 10. Stage 1 from all sessions are included in this analysis.
[1] In the questionnaire we asked "How do you consider your math capabilities?" The answers were Lower than Average (10.42 %), On Average (66.67%), Higher than the Average (22.92%)
[2] Dummy variable for Yes and No, in the questionnaire we asked "Do you like to bet?"
(* 0.1, ** 0.05, *** 0.01)

In Stage 2B, informing participants about the independence of rounds helps the risk-averse subsample to change their behavior toward AW outcomes; instead risk-seekers and risk-lovers positively and significantly allocate more tokens to the risky option after seeing the AW bias in the IG framing. This result is very surprising, as individuals showing risk averse preferences were more likely to be affected by AW outcomes, but nudging helps them to correctly consider the past round as an independent event. At the same time, risk-neutral and risk-seeking individuals decrease significantly the tokens allocated compared to the first stage, but it is more likely to incur in the misrepresentation of AW outcomes. When individuals play safer, the AW becomes more relevant.

## 3.4 Robustness Check

Table 8: Robustness check by framing, information and AW

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | Token allocation in risky choice | | | | | | | | |
| | Stage 1 | | | Stage 2A | | | Stage 2B | | |
| | All | RA | RN+RS | All | RA | RN+RS | All | RA | RN+RS |
| | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) | $\beta$/(se) |
| L.AW | 0.31 | 0.55* | 0.17 | 0.05 | -0.25 | 0.18 | 0.54** | 0.56* | 0.55 |
| | (0.19) | (0.30) | (0.25) | (0.26) | (0.37) | (0.30) | (0.24) | (0.34) | (0.34) |
| Tr IG | 0.50** | -1.10*** | 1.25*** | -0.54** | -2.79*** | 0.61* | 0.38 | 0.49 | 0.98*** |
| | (0.20) | (0.42) | (0.24) | (0.27) | (0.70) | (0.35) | (0.26) | (0.54) | (0.37) |
| Round | -0.12*** | -0.12*** | -0.12*** | 0.06*** | 0.11*** | 0.04 | -0.03 | -0.01 | -0.03 |
| | (0.01) | (0.03) | (0.02) | (0.02) | (0.04) | (0.03) | (0.02) | (0.03) | (0.03) |
| L.Winning * L.Payoff | 0.40*** | 0.79*** | 0.27*** | 0.64*** | 0.62** | 0.63*** | 0.27 | 0.70* | 0.17 |
| | (0.08) | (0.16) | (0.10) | (0.13) | (0.27) | (0.15) | (0.17) | (0.38) | (0.19) |
| L.Winning | -4.23*** | -8.52*** | -2.81** | -6.98*** | -7.66*** | -6.34*** | -2.34 | -6.25 | -2.48 |
| | (1.03) | (1.80) | (1.26) | (1.43) | (2.84) | (1.66) | (1.93) | (4.66) | (2.15) |
| L.Payoff | -0.34*** | -0.52*** | -0.28*** | -0.67*** | -0.74*** | -0.66*** | -0.24** | -0.39* | -0.14 |
| | (0.05) | (0.10) | (0.06) | (0.09) | (0.21) | (0.10) | (0.11) | (0.24) | (0.13) |
| Risk[1] | 0.35*** | | | 0.60*** | | | 0.11** | | |
| | (0.04) | | | (0.07) | | | (0.05) | | |
| Male | -0.00 | 0.32 | 0.04 | -0.32 | 0.30 | -0.07 | -0.23 | -0.30 | -0.76** |
| | (0.17) | (0.30) | (0.21) | (0.25) | (0.51) | (0.30) | (0.26) | (0.41) | (0.37) |
| Self evaluation on math capabilities[2] | -1.61*** | -0.85*** | -1.89*** | -1.17*** | -1.42*** | -0.96*** | -3.41*** | -1.62*** | -5.32*** |
| | (0.18) | (0.29) | (0.21) | (0.24) | (0.48) | (0.31) | (0.35) | (0.37) | (0.65) |
| Do you like betting?[3] | 0.78*** | 1.71*** | 0.65*** | 0.20 | 2.00** | -0.26 | 0.17 | -0.96* | 2.30*** |
| | (0.18) | (0.41) | (0.20) | (0.26) | (0.93) | (0.30) | (0.30) | (0.55) | (0.51) |
| Constant | 4.65*** | 5.31*** | 7.18*** | 2.60** | 5.80** | 6.41*** | 7.17*** | 6.11*** | 8.48*** |
| | (0.69) | (1.24) | (0.65) | (1.27) | (2.38) | (1.28) | (0.90) | (2.31) | (0.77) |
| Constant($\sigma_u$) | 3.01*** | 2.67*** | 3.03*** | 3.41*** | 2.73*** | 3.45*** | 3.27*** | 3.06*** | 2.79*** |
| | (0.14) | (0.25) | (0.17) | (0.24) | (0.51) | (0.29) | (0.27) | (0.48) | (0.31) |
| Constant($\sigma_e$) | 3.54*** | 3.21*** | 3.66*** | 3.62*** | 2.77*** | 3.82*** | 2.49*** | 2.33*** | 2.53*** |
| | (0.11) | (0.18) | (0.12) | (0.17) | (0.25) | (0.20) | (0.17) | (0.30) | (0.19) |
| Observations | 2736 | 969 | 1767 | 1824 | 570 | 1254 | 912 | 399 | 513 |
| $\rho$ | 0.42 | 0.41 | 0.41 | 0.47 | 0.49 | 0.45 | 0.63 | 0.63 | 0.55 |
| $N_{lc}$ | 1126.00 | 502.00 | 624.00 | 1101.00 | 420.00 | 681.00 | 488.00 | 251.00 | 237.00 |
| $N_{rc}$ | 183.00 | 42.00 | 141.00 | 71.00 | 8.00 | 63.00 | 18.00 | 4.00 | 14.00 |
| $\sigma_e$ | 3.54 | 3.21 | 3.66 | 3.62 | 2.77 | 3.82 | 2.49 | 2.33 | 2.53 |
| $\sigma_u$ | 3.01 | 2.67 | 3.03 | 3.41 | 2.73 | 3.45 | 3.27 | 3.06 | 2.79 |

**Notes**: Estimation bootstrapping with 999 repetition, standard errors in parenthesis.
Panel tobit regressions with random effects, censored at 0 and 10. Stage 1 from all sessions are included in this analysis.
[1] The risk is measured from 0 (max. risk averse) to 10 (max. risk lover).
[2] In the questionnaire we asked "How do you consider your math capabilities?" The answers were Lower than Average (10.42 %), On Average (66.67%), Higher than the Average (22.92%)
[3] Dummy variable for Yes and No, in the questionnaire we asked "Do you like to bet?"
(* 0.1, ** 0.05, *** 0.01) (* 0.1, ** 0.05, *** 0.01)

In order to provide a robust test of our results on framing, AW outcomes and

information, without relying on distributional assumptions, we adopt the Bootstrap procedure. Table 8 proposes a summary of the analysis carried out.
Results from Table 8 confirm our previous analysis and some additional considerations might be done. AW outcomes are affecting particularly risk-averse subjects in Stage 1, while the coefficients from Stage 2A confirm that the effect completely disappear. In Stage 2B, AW effect is statistically significant for all individuals, confirming that nudging is not the best option to teach individuals how to face AW bias. Thank to the Bootstrap method we find a significant trend toward framing: Risk-averse individuals tend to invest more in the SM game, while risk-loving and risk-neutral individuals invest 1.25 tokens more (on average) on the risky choice when playing the investment game. This last trend is weakened by information stages. Finally, self evaluation on math capabilities are always negatively related to higher allocations of tokens to the risky choice, while people who like betting tend to play more in Stage 1.

# 4 Final Remarks

This work started as an attempt to study AW biases considering different frames and information, and the analysis got even more interesting when results pointed out that the AW bias was strengthened by these additional elements. We show through this experiment that the effect of near-misses is not only related to compulsive gamblers and with pure gambling environments, it is also related to in general agents who do not apply their knowledge of randomness in a game of chance and therefore develop irrational thinking. Our result underlines that individuals are more confident in investing larger shares of their endowment in the investment game, either driven by a possible bias which increased their overconfidence or they could have different sensation-seeking and arousal depending on the game proposed (Anderson and Brown 1984, Ladouceur et al. 1991, Odean 1998). As described by Langer (1975), in skill situations people try to behave as if they are maximizing the probability of success; choosing the strategy which should lead to the best outcome is a primary component of the skill game, and those related game skills may be responsible for the illusion of control.
In this sense, individuals playing in the IG framing are overestimating their probability of success, given that the financial market is mostly associated to investment abilities, but their bias toward AW is similar both in slot machine and investment game framings. When we test the role of information on AW effect we conclude that providing different information promotes agents' rational behavior, in particular winning probabilities help them to correctly perceive the cognitive bias related to almost winning outcomes and it induces a rational and safer behavior in partic-

ipants right after informing them. Warning them on the cognitive bias due to AW outcomes induces a decreasing level of betting throughout the rounds, but this passage is smoother compared to individuals aware of the winning probability.

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# A Instructions

Welcome to our experiment!

You are participating in an experiment in which you will make several economic decisions.

We are interested only to your decisions that will remain completely anonymous: this means that the experimenters will not be able to associate any decisions to your name.

These decisions will directly affect your payment for the experiment. At the end og the experiment you will be paid cash privately. In particular, in each stage of the experiment you will gain several ECU (Experimental Currency Units) that will be exchanged at the following rate:

$$1 \text{ ECU} = 0.5 \text{ €}$$

In this experiment you will take your decisions in different situations that we call “Stages”.

The experiment consists of three Stages and a final Questionnaire.

Each Stage includes different rounds. Each decision that you will make and the result obtained in each Stage is independent from the others; this means that decisions taken in a Stage do not affect your results in any other Stage of the experiment.

At the end of the experiment, the computer randomly selects one round for each Stage and you will be paid the sum of the payoffs you realized in each round randomly selected.

In the following Instructions we will explain in details your task in each Stage.

After reading aloud the Instructions you will have some time to read them on your own. If you have any doubt please raise your hand and wait: one experimenter will come and help you individually as soon as she can. During the experiment work in silence and do not disturb other participants.

Enjoy

**STAGE 1, Investment Game**

In this Stage you have to decide how to invest your initial endowment for 20 rounds.

At the beginning of each round you will be endowed with 10 ECU and you have to allocate them between a risk free investment and a risky investment, based on a portfolio of three shares of three firms operating in independent markets, namely Microlift, Chip Corporation and Dolltech that DO NOT exist in the reality.

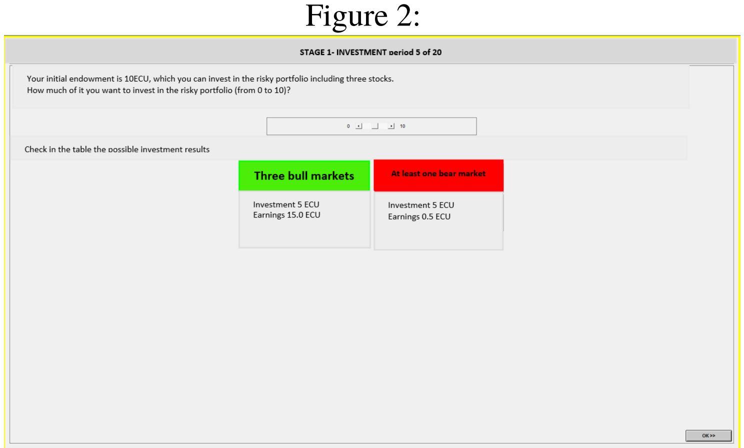
The risk free investment gives a zero net gain return, i.e. what you will invest in it will be entirely repaid to you no matter the trend of the three markets will be.

Your gain from the risky investment depends on the trend of the three markets. In particular, when all the markets are characterized by a bullish trend your initial investment is tripled. Whenever occurs one bear market you will experience a loss and your investment gain will be equal to 1/10 of your initial investment.

Assume, as an example, that in a given round you decide to invest 5 ECU in the risk free investment and 5 ECU in the risky investment. Your actual gain from this round will be determined by the trend of the three markets and by the amount of your endowment allocated to each investment. Since the repayment factor of the risk free investment is 1, you will gain 5 ECU for sure plus 15 ECU from the risky investment if all the 3 markets will have a positive trend. On the contrary if one or more of the markets will have a doom your gain will be: 5 ECU from the risk free investment plus 0.5 ECU from the risky investment.

To illustrate your choice task, look at Figure 2 where 5 ECU are invested in the risky portfolio represented by the scroll bar cursor. The potential gains with three bullish markets is represented in the green box; whether one market does not have a bullish trend, potential gains are represented in the red box.

Figure 2:



*Remember, you can move the cursor of the scroll bar to know all possible outcomes before confirming your final decision: you can check the potential results of your investment decision by scrolling the cursor on the bar. When you decide your preferred allocation, click OK.*

When you confirm the investment allocation, the computer will show the three markets result. Figure 3 and Figure 4 show two possible examples of the result shown on the screen. The final result of your investment is computed below the market outcomes, and it computes the ECU gained in that round.

Figure 3:

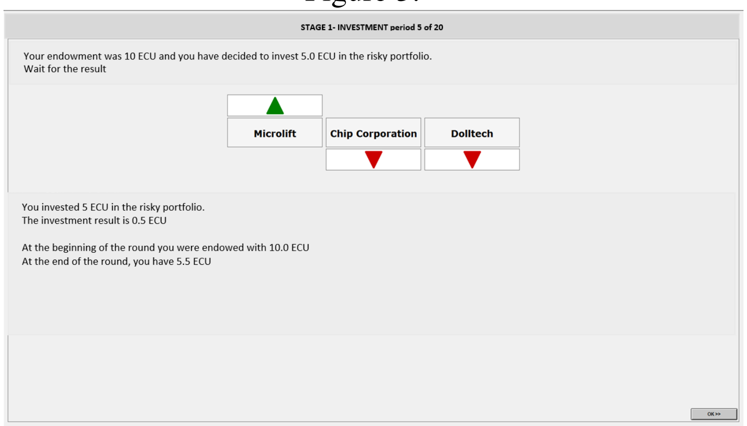
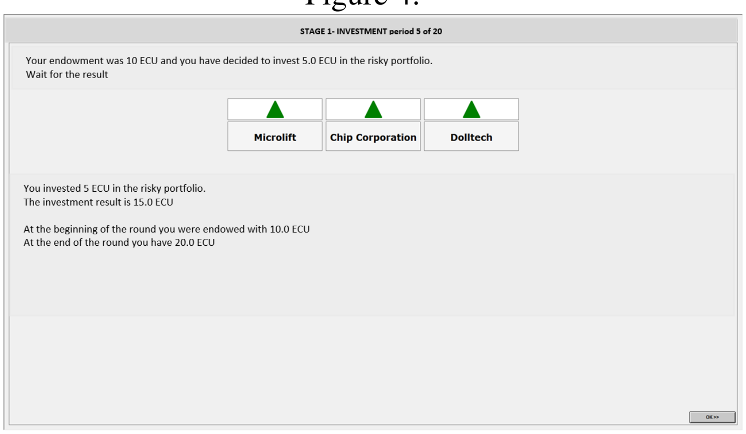



Figure 4:




In each round of Stage 1 you will receive the same initial endowment, i. e. in each of them you will have always 10 ECU to invest.

At the end of Stage one you will have also to answer to a question based on the 20 round played that will give you the possibility to gain 4 extra ECU.

At the end of the experiment the computer will randomly select just one round of Stage 1 and your actual gain from Stage 1 will be given by the amount of ECU you realized in that round plus 4 Ecu depending on how you answered to the final question on Stage 1.

## STAGE 1, Slot Machine

In this Stage you have to decide how to bet your initial endowment for 20 rounds.

At the beginning of each round you will be endowed of 10 ECU and you will have to decide how much of them to bet on a slot machine or to keep in your pockets. This is a one row slot machine with three cells. The possible outcomes from the slot machine are the following: "BAR", "Cherry", "Lemon", "Pear", "Strawberry".

Your gain from bidding depends on the occurrence of the "BAR". In particular, when "BAR" occurs in all the cells your bet is tripled. Whenever occurs one or more cells different from "BAR", you will experience a loss and your gain will be equal to 1/10 of your initial bet.

At the beginning of each round you will be asked how much you want to bet; for any possible choice (moving the cursor of the scrolling bar in Figure 5) the computer will show you in the green box your potential gain in case of winning (the occurrence of three "BAR") and your potential gain in RED box otherwise.

Figure 5:


When you confirm the investment allocation, the computer will show you the slot machine.

Assume, as an example, that in a given round you decide to bet 5 ECU in the slot machine and to keep the remaining 5 ECU of your endowment in your pocket. Your actual gain from this round will be determined by the 5 ECU you are not betting and by the slot machine result.

If 3 "BAR" will occur, as illustrate in Figure 6, your payoff for the round will include the 5ECU you did not bet and 15 ECU from your bet that has been tripled. Otherwise, if one or more than one icons will be different from "BAR" your payoff for the round will be equal to the sum of the 5 ECU you did not bet plus 0.5 ECU (that is 1/10 of your initial bet), as shown in Figure 7.

*Remember, you can move the cursor of the scroll bar to know all possible outcomes before confirming your final decision: you can check the potential results*

Figure 6:

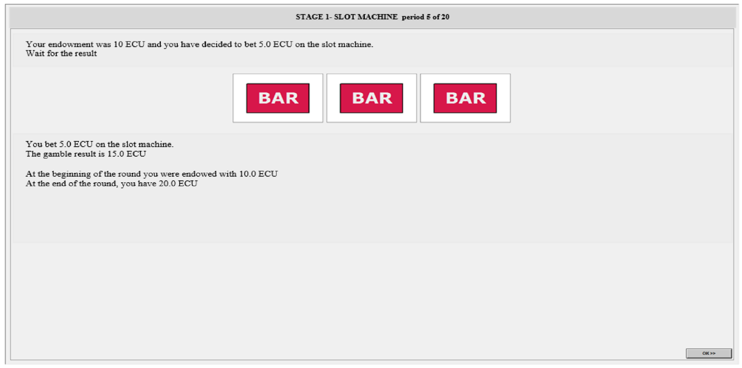
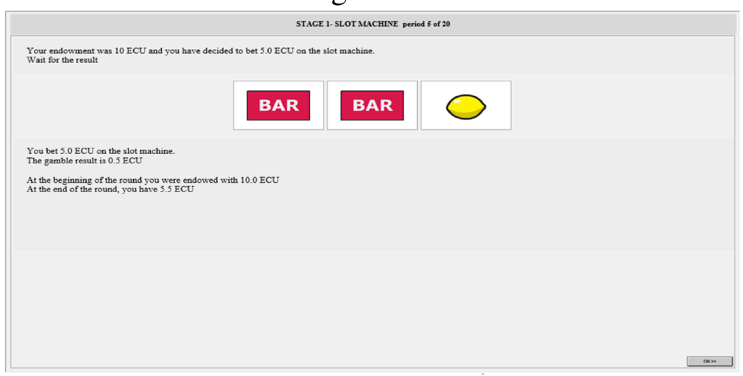



Figure 7:




*of your betting decision by scrolling the cursor on the bar. When you decide your preferred allocation, click OK.*

In each round of Stage 1 you will receive the same initial endowment, i. e. in each of them you will have always 10 ECU to bet.

At the end of Stage one you will have also to answer to a question based on the 20 round played that will give you the possibility to gain 4 extra ECU.

At the end of the experiment the computer will randomly select just one round of Stage 1 and your actual gain from Stage 1 will be given by the amount of ECU you realized in that round plus 4 Ecu depending on how you answered to the final question on Stage 1.

**STAGE II, Investment Game (Stage 2A, Probability)**

Stage 2 presents the same structure of Stage 1. During this Stage you will take the same investment decisions between a risk free and a risky investment with an initial endowment of 10 ECU for 20 rounds.

Additionally to the information of Stage 1, in this Stage 2 the computer communicates you the probability that the three markets have a bullish trend for all rounds.

At the end of the experiment the computer will randomly select just one round of Stage 2 for payment and your actual gain for this Stage will be determined by the amount of ECU you realized in the selected round.

**STAGE II, Investment Game (Stage 2B, Warning)**

Stage 2 presents the same structure of Stage 1. During this Stage you will take the same investment decisions between a risk free and a risky investment with an initial endowment of 10 ECU for 20 rounds.

Additionally to the information of Stage 1, in this Stage 2 the computer communicates you a warning message related to the probability that the three markets have a bullish trend in the following round.

At the end of the experiment the computer will randomly select just one round of Stage 2 for payment and your actual gain for this Stage will be determined by the amount of ECU you realized in the selected round.

**STAGE II, Slot Machine (Stage 2A, Probability)**

Stage 2 presents the same structure of Stage 1. During this Stage you will asked to bid in a slot machine with an initial endowment of 10 ECU for 20 rounds.

Additionally to the information of Stage 1, in this Stage 2 the computer communicates you the actual probability of the occurrence of 3 “BAR” for all rounds.

At the end of the experiment the computer will randomly select just one round of Stage 2 for payment and your actual gain for this Stage will be determined by the amount of ECU you realized in the selected round.

**STAGE II, Slot Machine (Stage 2B, Warning)**

Stage 2 presents the same structure of Stage 1. During this Stage you will asked to bid in a slot machine with an initial endowment of 10 ECU for 20 rounds.

Additionally to the information of Stage 1, in this Stage 2 the computer communicates you a warining message related to the probability that three “BAR” occur in the following round.

At the end of the experiment the computer will randomly select just one round of Stage 2 for payment and your actual gain for this Stage will be determined by the amount of ECU you realized in the selected round.

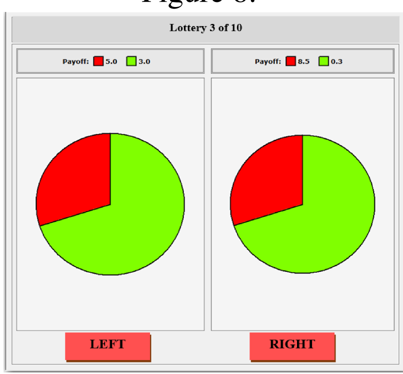
**STAGE III**

In this Stage you wil be asked to choose between lotteries with different prizes and chances of winning. You will be presented with a series of 10 lotteries where you will make choice between pairs of them.

For each pair of lotteries, you should indicate which of the two lotteries you prefer to play. You will actually get the chance to play one of the lotteries you choose, and will be paid according to the outcome of that lottery, so you should think carefully about which lotteries you prefer.

Figure 1ì8is an example of what the computer display of such a pair of lotteries will look like. The display on your screen will be bigger and easier to read.

Figure 8:




Each lottery assigns a given probability (indicated by the corresponding slice) to win 4 different prizes, respectively: 0.3 ECU, 3 ECU, 5 Ecu and 8.5 ECU represented by the area of the corresponding colour that will remain the same during the 10 rounds.

In the above example the probability that the LEFT lottery pays 3 ECU is associated to the green colour area; the same probability is associated in the RIGHT lottery to a prize of 0.3 ECU. The probability that the lottery on the LEFT (RIGHT) pays respectively 5 ECU (8.5 ECU) is associated to the RED area.

Each pair of lotteries is shown on a separate screen on the computer. On each screen, you should indicate which of the lotteries you prefer to play by clicking on one of the two boxes beneath the lotteries. You should click the LEFT box if you prefer the lottery on the left, the RIGHT box if you prefer the lottery on the right.

Be careful: You should approach each pair of lotteries as if it is the one out of the 10 that you will play out, since at the end of the experiment the computer will randomly select one of the 10 rounds and you will play for real the lottery you selected in that round.

After you have worked through all of the pairs of lotteries, wait in silence that all participants end that Stage too. There is no reason to rush into, we will wait for everyone taking his/her choices.

At the end of the experiment the computer will select one of the 10 rounds and it will play for real the lottery that you have chosen in that run: a spinning device will appear on your screen on a “wheel of fortune”. Note that each round has the same probability to be selected. Once the computer will select the round to be implemented on your screen will appear the corresponding lottery pair with in evidence the one you choose in that round.

Assume, for the sake of an example, that you preferred, as shown above, the lottery on your LEFT. On it will appear a random device:

- if it will stops in the GREEN AREA you will gain 3 ECU for this Stage;
- if it will stops in the RED AREA you will gain 5 ECU for this Stage.

Summing up your payoff for this Stage is determined by 3 elements:

- which of the 10 rounds will be selected for payment;
- which lottery you preferred in that round (LEFT or RIGHT);
- the result of the random draws in the selected lottery.

## YOUR PAYOFF FROM THE EXPERIMENT

Your final payoff from the experiment is given by the sum of the payoffs you gained in each Stage of the experiment More in details:

- your gain for the randomly selected round in Stage 1;
- 4 Ecu in case you answered correctly to the question proposed at the end of Stage 1 and 0 ECU otherwise;
- your gain for the randomly selected round in Stage 2;
- your gain for the randomly selected lottery in Stage 3.

# B Maximization Problem

We represent the utility function as:

$$U(x_1, h, l, p_h, p_l, e) = p_h \cdot u(h \cdot x_1) + p_l \cdot u(l \cdot x_1) + u(e - x_1) \tag{3}$$

We keep general risk preference for the maximization, and the following maximization problem is:

$$\max_{x_1} p_h u(h \cdot x_1) + p_l u(l \cdot x_1) + u(e - x_1) \tag{4}$$
$$\text{s.t. } x_1 \geq 0$$
$$e - x_1 \geq 0$$

and the lagrange form with $\lambda_1 \geq 0$ and $\lambda_2 \geq 0$:

$$L(x_1, \lambda_1, \lambda_2) = p_h u(h \cdot x_1) + p_l u(l \cdot x_1) + u(e - x_1) + \lambda_1(x_1) + \lambda_2(e - x_1) \tag{5}$$

where FOC:

$$\frac{\partial L}{\partial x_1} = 0 \tag{6}$$
$$p_h h \cdot u'(hx_1) + p_l l \cdot u'(lx_1) - u'(e - x_1) + \lambda_1 - \lambda_2 = 0$$

Then, we optimize for the different values assumed by $\lambda_1$ and $\lambda_2$

1. When $\lambda_1 = \lambda_2 = 0$, $x_1 > 0$ and $e - x_1 > 0$

$$p_h h \cdot u'(hx_1) + p_l l \cdot u'(lx_1) = u'(e - x_1) \tag{7}$$
$$p_h h \cdot u'(hx_1) + (1 - p_h) l \cdot u'(lx_1) = u'(e - x_1) \tag{8}$$
$$p_h(h \cdot u'(hx_1) - l \cdot u'(lx_1)) = u'(e - x_1) - l \cdot u'(lx_1) \tag{9}$$
$$p_h = \frac{u'(e - x_1) - l \cdot u'(lx_1)}{(h \cdot u'(hx_1) - l \cdot u'(lx_1)} \tag{10}$$

2. When $\lambda_1 > 0$ and $\lambda_2 = 0$, $x_1 = 0$

$$p_h h \cdot u'(hx_1) + p_l l \cdot u'(lx_1) + \lambda_1 = u'(e - x_1) \tag{11}$$
$$p_h = \frac{u'(e - x_1) - l \cdot u'(lx_1) - \lambda_1}{h \cdot u'(hx_1) - l \cdot u'(lx_1)} \tag{12}$$

3. When $\lambda_1 = 0$ and $\lambda_2 > 0$ implies $x_1 = e$

$$p_h h \cdot u'(hx_1) + p_l l \cdot u'(lx_1) - \lambda_2 = u'(e - x_1) \tag{13}$$

$$p_h = \frac{u'(e - x_1) - l \cdot u'(lx_1) + \lambda_2}{h \cdot u'(hx_1) - l \cdot u'(lx_1)} \tag{14}$$

When we consider the linear case for risk neutral individuals, we obtain:

1. When $\lambda_1 = \lambda_2 = 0$

$$p_h = \frac{1 - l}{h - l} \tag{15}$$

   Then we know that $p_h < 1$, then:

$$\frac{1 - l}{h - l} < 1 \tag{16}$$

$$h > 1 \tag{17}$$

   In this case each allocation of $x_1$ would be the optimal choice.

2. When $\lambda_1 > 0$ and $\lambda_2 = 0$

$$p_h = \frac{1 - l - \lambda_1}{h - l} \tag{18}$$

   where $\lambda_1 > 1 - h$

3. When $\lambda_1 = 0$ and $\lambda_2 > 0$

$$p_h = \frac{1 - l + \lambda_2}{h - l} \tag{19}$$

   where $\lambda_2 < 1 - h$.

# C Figures and Tables

Table 9: Elicited beliefs on probabilities by Stage and framing

| | Guessed probability of winning | | | |
|---|---|---|---|---|
| | Slot Machine | Investment Game | SM+IG | WRT |
| Stage 2A | 14.029 | 16.392 | 15.210 | 0.817 |
| | (24) | (24) | (48) | |
| Stage 2B | 17.158 | 12.983 | 15.071 | 0.157 |
| | (12) | (12) | (24) | |
| Stage 2 (A+B) | 15.072 | 15.256 | 15.164 | 0.305 |
| | (36) | (36) | (72) | |
| WRT | 0.176 | 0.758 | 0.488 | |

**Notes**: All tests reported are two-sided Wilcoxon Rank Sum Test (WRT). In parenthesis the number of observations. We consider only sessions were AW were forced and so more frequent.

Figure 9: Allocation of tokens, risk seeking individuals, Random AW

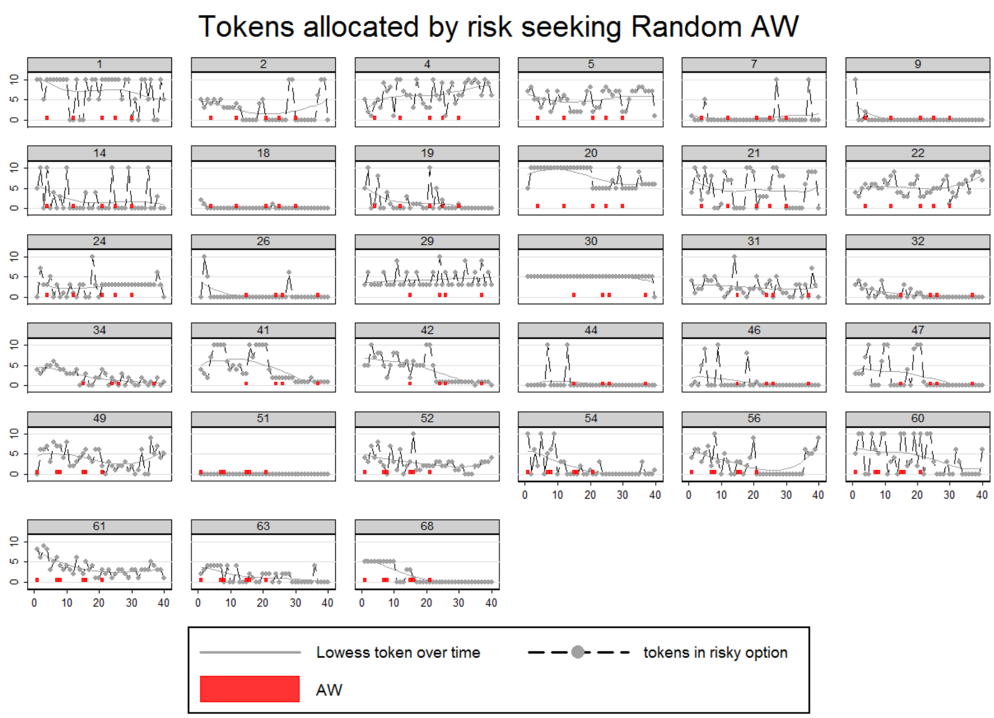


Figure 10: Allocation of tokens, risk seeking individuals, Forced AW

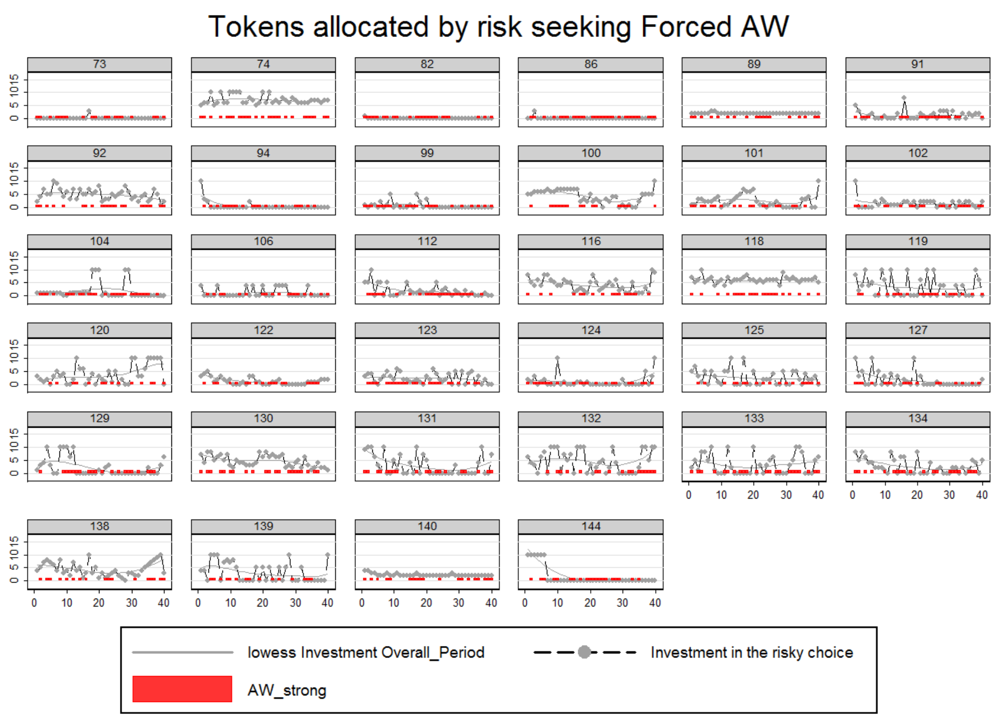


Figure 11: Allocation of tokens, risk neutral individuals, Random AW

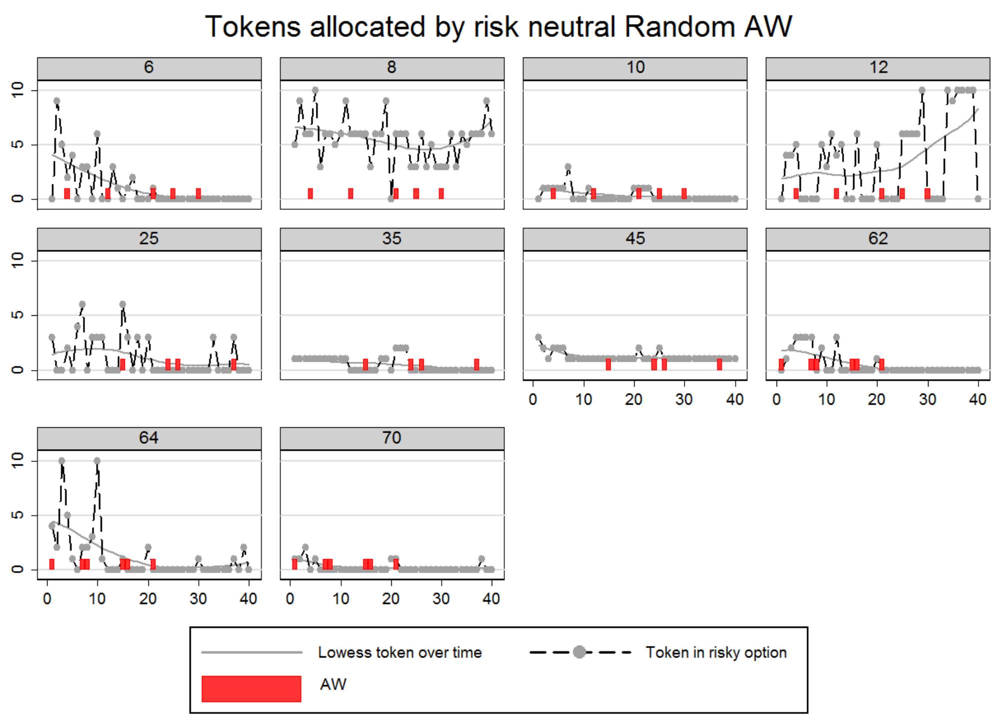


Figure 12: Allocation of tokens, risk neutral individuals, Forced AW

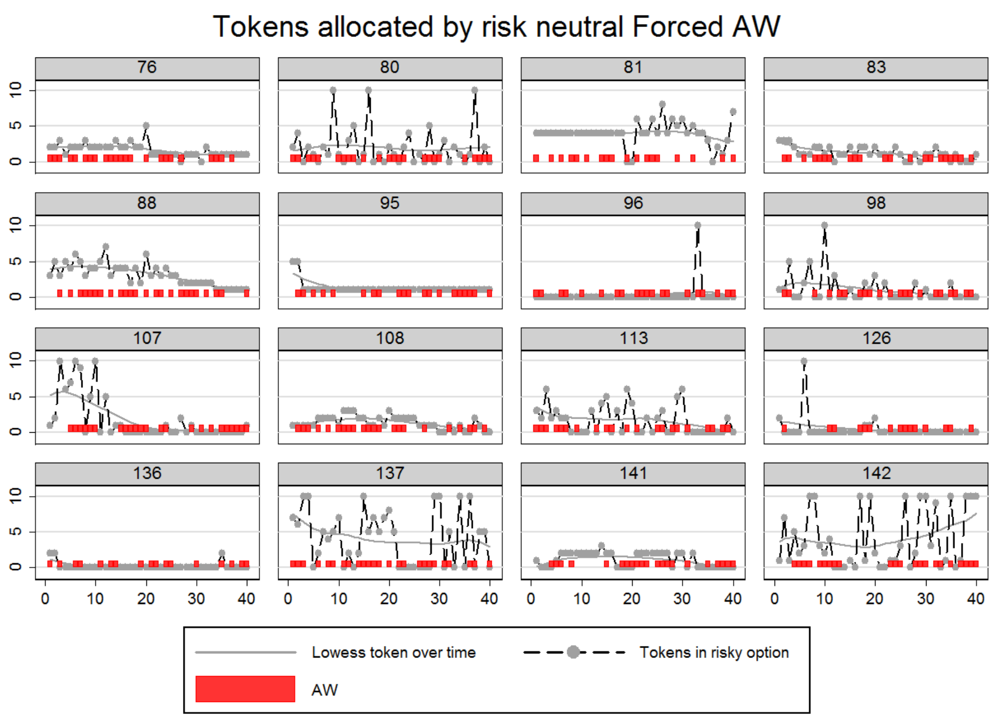


Figure 13: Allocation of tokens, risk averse individuals, Random AW

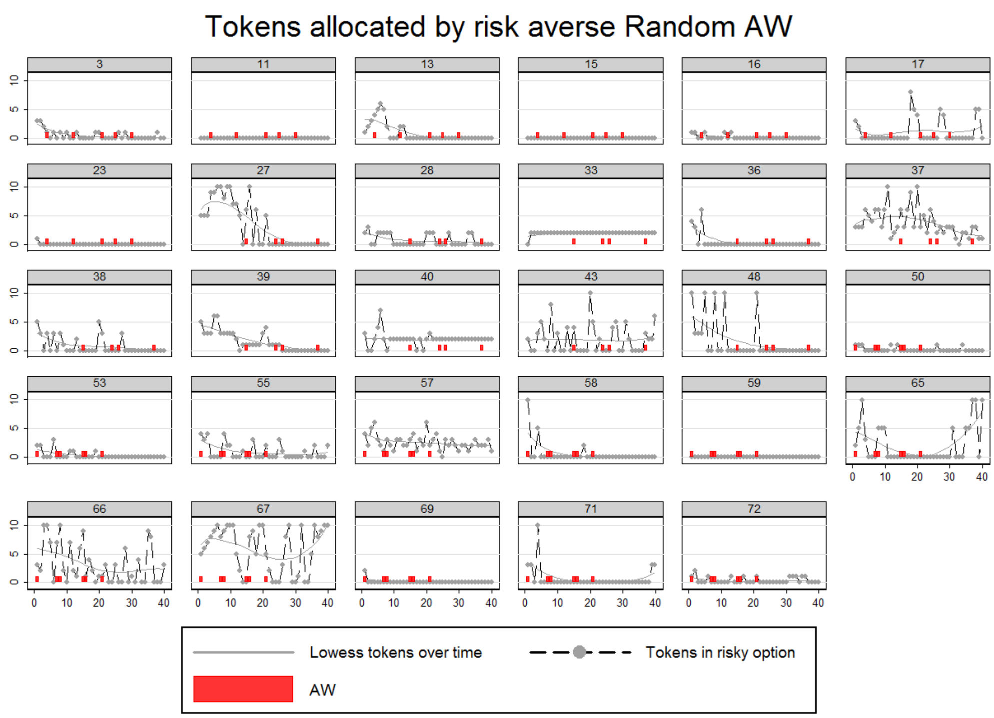


Figure 14: Allocation of tokens, risk averse individuals, Forced AW