Marcleiton Ribeiro Morais

Two essays on experimental economics

Brasília

Mar 28, 2020

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Thesis presented to the Doctoral Program in Economics, University of Brasilia as a requirement to obtain the title of Doctor in Economic Sciences.

University of Brasilia – UnB

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Supervisor: José Guilherme de Lara Resende

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For Judilene and Adam Benjamin

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"A little science stranges men from God,
but much science leads them back to Him"
(Louis Pasteur, 1822-1895)

Abstract

This thesis uses the Prospect Theory framework to contribute in two open questions: (i) Does the hot hand belief endogenously affect individual portfolio selection?, and (ii) Is there a limit to the effect of aggregation on Myopic Loss Aversion (MLA)? We ran lab experiments with undergraduate students at two Brazilian universities to address these two questions. In the second chapter, we test how the hot hand self-belief affects the individual portfolio selection in the presence of Loss Aversion (LA). Our experimental design used portfolio decisions considering random prices that were obtained from a predefined system so that the hot hand belief was defined as a wrong expectation about the price formation, and estimated considering how the investor evaluated both information about previous prices and investment performances. The portfolio dimension and the risk-return patterns were defined to attenuate confusion about the diversity of the asset price distributions, while the price formation aimed to attenuate familiarity about the development of prices. The results show that the propensity to buy is, in part, positively correlated with the price changes. More frequency of success in the investments made the hot hand show up in data, but the loss-averse investor profile dominated the portfolio management when the participant faced persistent negative price trends, making the hot hand effect fade away. In the third chapter, we got a representative sample for the experimental design proposed by Schoti (2012) in order to evaluate investors facing the frequency of feedback and the flexibility of choice smaller than what was provided to participants in the study conducted by Gneezy and Potters (1997). Schoti's study proposed a new treatment group in which participants played the rounds under more aggregated conditions to receive extremely low frequency of information, further limiting MLA. Our results support Schoti's hypothesis showing that MLA is positively related to the information frequency and the flexibility of choice, but also that the effect of these variables on the myopia is decreasing. Participants in our experiment exhibited less risk aversion and bet more significant amounts when they faced more limited feedback and choices. However, doubling the feedback and choice restrictions did not produce twice less myopia, suggesting that the effect is not linear.

Keywords: Hot hand belief. Myopia. Loss Aversion.

Resumo

Esta tese faz uso do ferramental Teoria do Prospecto para contribuir com duas questões em aberto: (i) A crença *hot hand* afeta endogenamente a seleção individual de portfólio?, e (ii) Existe um limite para o efeito da agregação na *Myopic Loss Aversion* (MLA)? Realizamos experimentos em laboratório com estudantes de graduação de duas universidades brasileiras para investigar essas duas questões. No segundo capítulo, testamos como a auto-crença *hot hand* afeta a seleção individual de portfólio na presença de *Loss Aversion* (LA). Nosso design experimental usou decisões de portfólio considerando preços aleatórios que eram obtidos de um sistema predefinido de modo que a crença *hot hand* fosse definida como um erro de expectativa a respeito da formação de preço, e estimada considerando como o investidor avaliava ambas as informações sobre preços passados e performances dos investimentos. A dimensão do portfólio e os padrões de risco-retorno foram definidos para atenuar confusão com relação à diversidade das distribuições dos preços dos ativos, enquanto a formação de preço objetivou atenuar familiaridade em relação ao desenvolvimento dos mesmos. Os resultados mostram que a propensão à compra é, em parte, positivamente correlacionada com as mudanças de preço. Maior frequência de sucesso fez a crença *hot hand* aparecer nos dados, mas o perfil investidor avesso à perda dominou a gestão do portfólio quando o participante enfrentou tendências negativas persistentes de preços, fazendo o efeito *hot hand* desaparecer. No terceiro capítulo, obtemos uma amostra representativa para o design experimental proposto pela Schoti (2012) para avaliar investidores diante de frequência de feedback e de flexibilidade de escolha menores que as permitidas aos participantes do estudo conduzido por Gneezy and Potters (1997). O estudo da Schoti propôs um novo grupo de tratamento no qual os participantes jogavam as rodadas sob condições mais limitadas para receber informações com frequência extremamente baixa, limitando ainda mais MLA. Nossos resultados sustentam a hipótese da Schoti mostrando que MLA é positivamente relacionada à frequência das informações e à flexibilidade de escolha, mas também que o efeito dessas variáveis sobre a miopia é decrescente. Os participantes do nosso experimento exibiram menos aversão a risco e apostaram quantias mais significativas diante de *feedback* e escolhas mais limitadas. No entanto, dobrando as restrições de *feedback* e de escolha não produziu duas vezes menos miopia, sugerindo que o efeito não é linear.

Paravras-chave: Crença hot hand. Miopia. Aversão a perda.

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List of abbreviations and acronyms

MLA	Myopic Loss Aversion
LA	Loss Aversion
EU	Expected Utility
PT	Prospect Theory
LSN	Law of Small Numbers
LLN	Law of Large Numbers
GVT	Gilovich, Vallone and Tversky (1985)
NBA	National Basketball Association
UFT	Federal University of Tocantins
FACE	Faculty of Economics, Accounting and Administration
UnB	University of Brasilia
i.i.d.	Independent and identically distributed
GP	Gneezy and Potters (1997)
EUA	Estados Unidos
HL	Haigh and List (2005)
FPT	Fernandes et al. (2016)

List of symbols

A	High-risk asset
C	Medium-risk asset
B	Low-risk asset
t	Period
θ_1	Coefficient of the hot hand effect considering previous price changes
θ_2	Coefficient of the hot hand effect considering previous gains and losses
U	Asset purchase after the price had gone up
D	Asset purchase after the price had gone down
G	Asset purchase after a gain
L	Asset purchase after a loss
H	High frequency feedback (treatment H)
L	Medium frequency feedback (treatment L)
E	Low frequency feedback (treatment E)
X	Amount of currency units
US$	US Dollar
€	Euro
$R$$	Real

Contents

Part I

Introduction

1 Introduction

This work addresses the following two questions: (i) Does the hot hand belief endogenously affect individual portfolio selection?, and (ii) Is there a limit to the effect of aggregation over Myopic Loss Aversion (MLA)?

In the second chapter, we designed an experiment that balances ambiguity and familiarity effects in a hypothetical financial market in order to test the hot hand belief, the belief that successful investments breed successful asset purchases even when the asset prices have a random formation. Our setup for the hot hand belief differs from others found in literature because we considered it an investor self-belief in order to isolate its direct effect on the portfolio selection. Our experimental design used portfolio decisions of a loss-averse investor involving assets with random prices in a way that the self-belief in a successful performance streak becomes a wrong expectation about the development of the prices. The hot hand effect was analyzed considering how the participants selected information about previous prices or even prior purchase performance such that the belief was also resulting from a representativeness error. Results show that the propensity to buy is, in part, positively correlated as prices go up or down. More frequency of success made the hot hand phenomenon show up in data, but the loss-averse investor profile dominated the portfolio management when the participant faced persistent negative price trends, making the effect fades away.

In the third chapter, we replicated the experimental design proposed by Schoti (2012) in order to test the myopic loss aversion hypothesis when investors received more aggregated information about their investments and had more limited choices about them. The Schoti's study introduced some innovations regarding previous studies to test how the risk-behavior changes when the frequency of feedback and flexibility of choice are smaller than what was provided to participants of previous experiments. The aggregation would tend to atenuate the incidence of MLA for the literature, but it does not make the relationship between them clear. We followed Schoti (2012) exactly intending to get a representative sample for their work. In the same way, as in Schoti (2012), we find that MLA is positively related to the information frequency and the flexibility of choice, but the effect of these variables on MLA is decreasing. Participants exhibited less risk aversion and bet more significant amounts when faced with more limited feedback and choices. However, doubling these restrictions did not produce twice less myopia, suggesting that the effect is not linear.

Additional to this introduction, Part II contains the three chapters, and Part III concludes. The protocols of the experiments are in Appendix A and Annex A.

Part II

Chapters

2 Does the hot hand belief endogenously affect individual portfolio selection?

2.1 Introduction

The investors' belief in the expertise of a management company and the players' belief in a 'fair coin-tossing expert' were the strategies used by finance researchers in order to isolate the hot hand effect, resulting from the cognitive illusion that uncorrelated random prices of an asset present positive autocorrelation. Both approaches consider this psychological component as exogenous to the decision-maker in the same way that the fans' belief in the hot hand is exogenous to sports players [Gilovich, Vallone and Tversky (1985), Hendricks, Patel and Zeckhauser (1993), Sirri and Tufano (1998) and Huber, Kirchler and Stöckl (2010)]. We used a computer-based experiment to test whether the hot hand phenomenon endogenously affects the decisions of a loss-averse investor in a hypothetical financial market. We aimed to understand how the hot hand self-belief affects the individual portfolio selection in the presence of Loss Aversion (LA). A loss-averse investor tends to perform gains soon and to keep losses too long while the 'hot' investor tends to perform both gains and losses impartially.

Our experimental design used portfolio decisions considering asset prices resulting from a random system so that the hot hand belief was defined as a wrong expectation about the price formation and estimated considering how the investor selected both information about previous prices and investment performances. The portfolio dimension and the risk-return patterns were defined to attenuate confusion about the diversity of price distributions (ambiguity bias), while the prices were defined in order to attenuate familiarity about their development (familiarity bias). The balance between these biases in a multi-asset portfolio composes our strategy to define the appropriated information set basis to the hot hand belief formation.

The participants received an endowment and had to make choices about investing in four assets, classified concerning risk: high, medium, low, and risk-free. The price system defined these different risk-return patterns and was informed to participants as well as each individual could follow the development of the prices on the game screen. The experiment had two treatment groups: treatment I and treatment II. People in the treatment I group made their decisions considering the original prices while individuals in the treatment II group faced manipulated price series to improve their performance initially. We compared both these groups after they had faced the same price series. The purchases were made at displayed prices and automatically sold at the beginning of the next period by new prices.

So, participants could observe their performances and purchase the same amounts back if they wanted to do so. In the end, participants had a chance to win a percentage of the cash accumulated.

We used this different setup compared to previous studies, especially Huber, Kirchler and Stöckl (2010), in order to induce the hot hand belief directly. Although we considered this belief a mistake produced by representativeness errors as previous studies do, our work examined its effects endogenous to the decision-maker. Both the direct effect of the hot hand belief and its relationship with LA have poor documentation in behavioral finance despite their importance in the investor decision. Our results show that the hot hand behavior endogenously affects the portfolio composition, but LA can dominate it in some circumstances. The propensity to buy is positively correlated with price changes in a way we isolate the hot hand effect in data, but it did not eliminate LA when participants faced persistent negative price trends, making the effect fade away.

Additionally to this introduction, Section 2.2 presents the theoretical framework that supports our experiment and a literature review to hot hand belief. Section 2.4 explains the experimental design (protocols are in Appendix A). Section 2.5 describes the results and Section 2.6 concludes.

2.2 Two theories

Expected Utility (EU) is the standard normative approach to model the investors' behavior. This theory assumes a rational investor who makes decisions that maximize the expected value of his payoff measured in some utility-scale. Under risk, rationality can be formulated in a set of axioms described as completeness, transitivity, continuity, and independence. Involving uncertainty conditions, the decision-makers also need to satisfy the *Sure-Thing Principle*[1] from Savage (1954) [See Myerson (2013) for more details]. The expected value of a utility function can represent preferences with these characteristics according to Bernoulli (1738) and Von-Neumann and Morgenstern (1947).

However, the systematic violation of theses axioms causes limitations in the explanatory power of the EU, such as when the preferences display risk-aversion to gains and risk-seeking to losses. These preferences have a reflection around zero and violate the independence axiom [Ellsberg (1961), Slovic and Tversky (1974) and MacCrimmon and Larsson (1979)]. Kahneman and Tversky (1979) tested some of the EU axioms and found evidence of behavior that does not satisfy these axioms. They formulated the Prospect Theory (PT)[2], which became the more prominent theory in behavioral and experimental

[1] This principle is closely related to independence and intuitively sets that if a choice A is dominant against B concerning two possible events, the choice could be made before any of them occurs.

[2] Barberis and Thaler (2003) list many theories that have no rationality framework of the EU like the PT, between them weighted-utility theory, implicit expected utility, disappointment aversion, regret theory,

economics.

The PT states that choices under risk show two distinct effects. First, they display the Certainty Effect, in which individuals overestimate lottery with certain outcomes over probable ones or a likely gain over a sure smaller loss. The preferences in these setups display risk aversion to sure gains and risk-seeking involving sure losses with a reflection around zero, violating the independence axiom. As a consequence, agents prefer bets with a high expected value and small variance to eliminate aversion to uncertainty and variability in lotteries. Second, these choices display the Isolation Effect, in which components shared by all prospects are discarded in favor of striking ones. This effect can lead to inconsistent preferences because an equivalent income level choice presented in different domains yields preference reversion [Kahneman and Tversky (1979)]. Thus, the utility function should contemplate gains and losses rather than final asset state, income level, or welfare as in the EU [Allais (1953), Ellsberg (1961), Swalm (1966), Slovic and Tversky (1974), MacCrimmon and Larsson (1979)].

The prospect value depends on choice weights and its implicit value assigned by a value function instead of linear probabilities and utility function as in the EU. Choice weights are assumed to be not coincident with probabilities but are nonlinear probability transformations that incorporate overweight of small probabilities and underweight of moderates and large ones. The implicit value of a prospect supports the diminishing sensitivity of a variation in an outcome from a relevant reference point. Thus, the lottery has a value defined regarding a reference point usually associated with the value zero in the subject value scale, and changes in utility level are measured by changes in the individual income level rather than final income level [Kahneman and Tversky (1979) and Fox and Poldrack (2009)].

Thus, preference representation in the PT is described over value functions dependent on income variations. These functions are convex for losses and concave for gains with a kink at the origin, but steeper for losses, since usually people are more sensitive for a loss than for a corresponding gain. This feature is called LA, and it means that 'losses loom larger than gains' [Kahneman and Tversky (1979, p. 279)].

2.3 The hot hand belief

The cognitive psychology literature states that a violation of rationality frequently arises when people form beliefs or when people make decisions based on their beliefs [Barberis and Thaler (2003)]. How to model the mechanism of belief formation is an important part of behavioral economics[3]. Generally, people are *overconfident* since they

and rank-dependent utility theories.

3 Kahneman et al. (1982) and Rabin (1998) offer complete documentation for the principal components of how people create expectations in practice.

exaggerate judging the occurrence of frequent events and minimize the frequency of rare ones. They are also *optimistic* overestimating their skills, prospects, and abilities to perform tasks. Individuals exhibit *representativeness errors* focusing on particular before general information. They also infer too much from extremely small samples generated by a process unknown to them. They are also *conservative* in updating information, revising too little prior evidence, and misreading new ones. They are *reluctant* to change their convictions, ignoring or evaluating new evidence with excessive skepticism. They also *anchor* their estimates in arbitrary values and poorly adjust them, and always consider recent or significant memories in estimating probabilities, causing distortions [Kahneman et al. (1982) and Rabin (1998)].

The term hot hand appeared first in basketball after athletes, experts and fans showed a belief that recent individual success in ball throws in a game would similarly occur in the next ball throw [Bar-Eli, Avugos and Raab (2006)]. Although related to other cognitive factors, Barberis and Thaler (2003) argue that the hot hand belief is mostly a representativeness problem and has its origin in the Law of Small Numbers (LSN) from Tversky and Kahneman (1971). This law states that people follow representativeness heuristics when evaluating the probabilities of an event. Individuals judge that a small sample presents the same essential characteristics of a population from which it was drawn, as well as any large sample drawn from this same population, will present according to the Law of Large Numbers (LLN) from Bernoulli and Huygens (1899). The sample is evaluated considering how much it is similar in essential properties to its parent population and how it reflects the salient features of the process by which it is generated [Tversky and Kahneman (1971) and Tversky and Kahneman (1974)].

Therefore, the hot hand belief can be seen as a cognitive illusion in which the agent self-promotes a positive autocorrelation in an uncorrelated random series. Gilovich, Vallone and Tversky (1985) (GVT) used this definition for the first time to analyze a survey of basketball fans, statistical data from the Philadelphia players and their opponents during the 1980-1981 season of the National Basketball Association (NBA), and free-throw data. They concluded that fans, most players, spectators, and students of the game believe in the hot hand, although they did not find evidence of causality between beliefs and players' performance in data. Tversky and Gilovich (1989) showed that contrarily to common belief, the chances of a player scoring are largely independent of the outcome of his or her previous shots. This finding is called hot hand fallacy.

More than thirty years of research reviewed the conclusions of GVT trying to find support to the hot hand behavior hypothesis [Bar-Eli, Avugos and Raab (2006)]. Some pieces of evidence pointed to failures in statistical tests and sample size selected by GVT, while others showed the existence of the effect to much larger data [Korb and Stillwell (2003) and Yaari and Eisenmann (2011)]. Miller and Sanjurjo (2018) replicated the GVT results using their data applied to bias correction and the same statistical tests used in GVT. They found the reverse of the GVT conclusions by proving the existence of streak selection bias in a standard measure of the conditional dependence of present results on streaks of past results in sequential data. This bias occurs because the proportion of heads in the set of results after a streak of heads in a finite series of fair coin tosses is expected to be strictly less than the conditional probability of its occurrence. The authors showed that this phenomenon frequency decreases with the series length and increases with the streak length. So, using a debiased analysis, their evidence showed a substantial presence of the hot hand effect in GVT sequence length.

At the same time, the appropriate definition for the hot hand term had a shift in the debate mainly in sports from a cognitive illusion to adaptive in the athletes' strategy in the match. Green and Zwiebel (2013) compared short-term predictability in the performance of a player who was temporarily shooting better than he usually did, for basketball and baseball players. They proposed that the hot hand belief would be interpreted as a strategic equilibrium adjustment rather than a cognitive mistake, by which endogenous responses of offenses and defenses equate marginal shots across players in the face of short-term changes on ability. The belief and the endogenous choices are then considered from an equilibrium perspective, such that their effects could not be directly observed in sports like basketball, where there is sufficient opportunity for defensive responses to equate shooting probabilities.

In finance, the hot hand effect was estimated considering the demand of management funds and throughout experiments [Hendricks, Patel and Zeckhauser (1993), Sirri and Tufano (1998) and Huber, Kirchler and Stöckl (2010)]. However, the belief was considered exogenous to the decision-maker in those estimations, assigned to him by a third party as if he were a specialist — third party people believing that the management company (decision-maker) is an expert. Hendricks, Patel and Zeckhauser (1993) observed that investors selected portfolios considering the recent performance of management funds. Sirri and Tufano (1998) argued that this selection is disproportionately more in funds that performed very well in the prior period, although many studies had demonstrated the difficulty for professional investment managers to earn higher than market gains systematically [Fama (1970), Fama (1991) and Malkiel (2005)].

The hot hand belief was also treated as an exogenous phenomenon by Huber, Kirchler and Stöckl (2010). They used experiments to evaluate financial decisions where individuals could bet on the outcomes of a series of coin tosses themselves, rely on randomized 'experts,' or choose a risk-free alternative. They observed that subjects chose considering the recent performance of the randomized 'experts,' revealing behavior compatible with the hot hand belief.

Similar to sports, individual financial choices have significant properties for testing streakiness in performance. There are no confusing influences from team play and defenses, but market dynamics impose reactions on the agent that forces him to adjust choices. If the investor is temporarily performing well, he will tend to maintain his strategy as long as market conditions do not change. As these conditions change, he must make adjustments in the expectation that his income will return to an expected standard [Green and Zwiebel (2013)]. This suggests the existence of causality between recent results and portfolio selection.

2.3.1 Hot hand effect and the prospect theory

How the investors' preferences could support the hot hand behavior is an essential question since information updates both the hot hand belief and preferences. PT considers that investors evaluate gains and losses from reference points (reference point effects) and are risk-seeking to losses and risk-averse to gains (reflection effects) [See Section 2.2]. Weber and Camerer (1998) used the interaction between these features to test the disposition effect, the tendency of investors to hold losing investments too long and sell winning investments too soon, as proposed by Shefrin and Statman (1985). Their predictions were confirmed by Odean (1998) using trading data. This tendency states a behavior contrary to what the hot hand belief predicts.

The basic idea is that individuals evaluate gains and losses relative to the purchase price or a weighted average of last prices[4] while behaving as risk-seeking for losses and risk-averse for gains. Thus, they will keep (sell) an asset after a loss (gain) even when they are choosing between to keep (sell) or to sell (keep) it, so accepting a gamble with a new uncertain loss (gain) and an uncertain gain (loss). That reveals that the disposition effect impacts the decision differently compared to the hot hand effect resulting from a cognitive illusion.

In practice, the correct specification of the disposition effect requires to evaluate whether the PT prediction is an accurate description for the preferences of the investors and to use correct tests of how they choose reference point [Weber and Camerer (1998)]. If the preferences are as in the PT, our formulation of the hot hand belief requires correct tests of how investors use pieces of information, including reference points, to form a heuristic of representativeness. Thus, the reflection effect promotes different impacts on decisions involving both those effects, although they could be both formulated from PT. LA reinforces the disposition effect when people compare gains and loss, and attenuates the hot hand behavior. A winning streak should drive a lower amount of purchases than the sales from a similar losing streak.

Besides, the hot hand effect can not be formulated in the same setup of the

[4] Barberis, Huang and Santos (2001, p.13) called the process of definition of the reference point as the *Dynamics of the Benchmark Level*.

disposition effect. The latter states that people believe that an aleatory series with a trend will get reversion in the next bet, even knowing that its process generation improves a tendency (autocorrelation). This belief is on an unexpected change in a tendency, in an unexpected average reversion according to Weber and Camerer (1998) and Chui (2001). An unexpected change in a trend resulting from an unbalanced series can not be considered endogenous concerning the series formation. However, the hot hand definition we consider states that people believe that an aleatory series will keep a tendency even knowing that its process generation is balanced (a random walk), that it does not induce tendency primarily. The belief here is on 'average trend maintenance.' So the hot hand belief (the 'average trend maintenance belief') evaluated considering the disposition effect setup is endogenous concerning the natural trend of the series generation process. Similarly, the disposition effect is endogenous about the trend reversion natural to the random walk series necessary to isolate the hot hand effect.

The loss aversion phenomenon should be considered in both the disposition effect and the hot hand setups. Essential in the former, LA has a contrary effect on the hot hand effect. As we cannot isolate its implications in this latter setup, the hot hand effect should be attenuated in the presence of LA.

2.4 Experimental design

Our experiment was computer-based, programmed in the z-Tree package from Fischbacher (2007) (version 3.6.7 dated June 21, 2016). Participants were presented to a series of purchase decisions of different assets in two stages. They could buy units of a high-risk asset (A), a medium-risk (B), and a low-risk asset (C), or do not buy any asset (risk-free asset). Each participant made six decisions in the first stage in order to become familiar with the game, observe their performance, and monitor the price behavior. In the second stage, each one made more ten decisions having a chance to win a percentage of the cash accumulated at the end of this stage (the percentage was 0.02%). Only a third of the participants in each session was randomly drawn to be entitled to payment.

Each asset was bought at a displayed price and automatically sold at the beginning of the next period by its new price. It could be bought back again with no transaction cost and no inflation. The prices of each asset were generated by a random process that we described in detail below.

The participant received an endowment of R$ 5000 (US$ 1198.94)[5] in each round to invest, with the possibility to maintain resources in cash without perceiving interest. They could not borrow short assets, and his participation ended automatically at any time if the portfolio value hit zero.

[5] One US dollar = 4,17 Reais on November 12, 2019, at 17:53 BACEN (2019).

Each participant could observe in the next round his outcomes after each investment decision. He also received feedback when he was playing better or worse than his average in the first stage. The above-average performance feedback was 'You have outperformed your average game performance,' and below was 'You underperformed your average game performance.'

At the beginning of each experimental session, participants received an explanation about those game rules. They also were informed about the price formation, and how they should use the program screen (Figure 8 from Appendix A) to record their decisions, find price information, and perform their purchases. The instructor followed the roadmap displayed in Appendix A when explaining all these game components.

Participants were informed about the price formation in the simplest possible way. They knew the initial asset prices and were oriented about how the following prices were obtained from an aleatory two-step draw. Where each price could increase or decrease with the same chance, but with three different and equally likely variations by assets so that we had three levels of risk-return (high, medium, and low). We explain the price system in detail next.

The program set prices from a pre-set algorithm that remained unchanged for all transactions. It assigned the value R$ 100 to all assets in the first round of the game and set each asset path randomly in two steps for all subsequent periods. In the first step, was chose the variation sign (+ or −) with probability ($P = 0.5$) and independently between assets. This criterion imposed variance to the prices and displayed distributions in which the probability of an increase was (P) and of a reduction was ($1 - P$). The second step determined the size of the variation. Here, the program chose the value of increase or decrease to each asset between three different values with equal chances of occurrence. These values in Brazilian reais were R$ 21, R$ 23 and R$ 25 for A; R$ 11, R$ 13 and R$ 15 for B; and R$ 1, R$ 3 and R$ 5 for C. Both the sign of the variation and its magnitude are independent. The price system distribution is described in Table 1.

Table 1 – The probability distribution of the price system

Asset	**Chance**		**Possible values (R$)***
	Increase (+)	Decrease (-)	
A			21, 23 e 25
B	0.5	0.5	11, 13 e 15
C			1, 3 e 5

Note: *Same chance (i.i.d.)

We chose to use these price distributions for two main reasons: 1) the belief in autocorrelation in that context is a wrong judgment of representativeness because stock prices have the same chances of rising and falling. Consequently, the hot hand belief was not endogenous concerning the price system and was on an 'average trend maintenance' basis since subjects believed in an unexpected trend [See Section 2.3.1]; 2) these distributions allowed participants to derive the asset price trends from price developments without an extraordinary competence in evaluating the gamble. By doing so, we intended to attenuate the familiarity bias that arises when the individual feels entirely comfortable in evaluating a lottery [Fox and Tversky (1995), Chew and Sagi (2008) and Ergin and Gul (2009)]. This bias could emerge in a fair coin toss as well as when the investor faces a price series in which prices increase or decrease by the same amount with an equal chance [Ayton and Fischer (2004)]. Our setup kept the same chance of price going up and going down to guarantee a random walk series, but it used three different possible values for the price chance to mitigate familiarity in price predictions. We put people in a portfolio decision situation facing three different price series also as part of this strategy of controlling familiarity. This feature of our experiment improves the experiment of Huber, Kirchler and Stöckl (2010), because they evaluated the hot hand effect using a fair coin toss.

Besides the two main reasons explained above, our design also has the advantage that the distributions of the multi-asset portfolio returns are approximately normal. Thus, an illustration of price and return distributions by mean and variance could not lead to imprecision considering an analysis by a nonquadratic utility [See Weber and Camerer (1992)].

The experimental design also controlled ambiguity bias since it could be improved while controlling familiarity. This bias was first proposed by Ellsberg (1961) and states that people feel confused about the great diversity of distributions of the price that can arise in designs such as Weber and Camerer (1998). This study used seven purchase options, including free risk-asset. We intended to attenuate ambiguity setting our portfolio dimension with only three risk-asset and a free risk-asset, defining strategically three risk-return levels (high, medium, and low).

The balance between familiarity and ambiguity in this multi-asset portfolio is part of our strategy to define the appropriate information set basis to the hot hand belief formation, as recommended by Ayton and Fischer (2004). Our formulation for the hot hand belief was on information-basis, so traders would make their investment decisions observing previous stock price movements in a chart and some reference points as maximum, minimum, and recent average price. This piece of information is shown on the left side of Figure 8 from Appendix A.

Finally, our design set a two-stage game with automatic sales based on other studies [Kroll, Levy and Rapoport (1988a), Kroll, Levy and Rapoport (1988b), Weber and Camerer (1992), Kroll and Levy (1992) and Weber and Camerer (1998)]. We used automatic sales in order to require the participant to repurchase assets in each round if he wanted to do so. By denying the subjects the possibility of holding on to their assets between the two rounds, we set up an environment that allowed the participants who faced the original price series (called treatment I group) with a group of individuals who had their performances deliberately improved in the first stage (called treatment II group).

We manipulate prices in the first stage to improve the outcomes in the treatment II group. The manipulation was made in three steps involving three following rounds: in the first round, participants bought at the original prices; at the beginning of the next round, the program changed the asset prices that would lead to losses, and participants observed their performance in a screen with no possible purchases; in the third round, we reversed the manipulation performed in the second one with no possible purchases again.

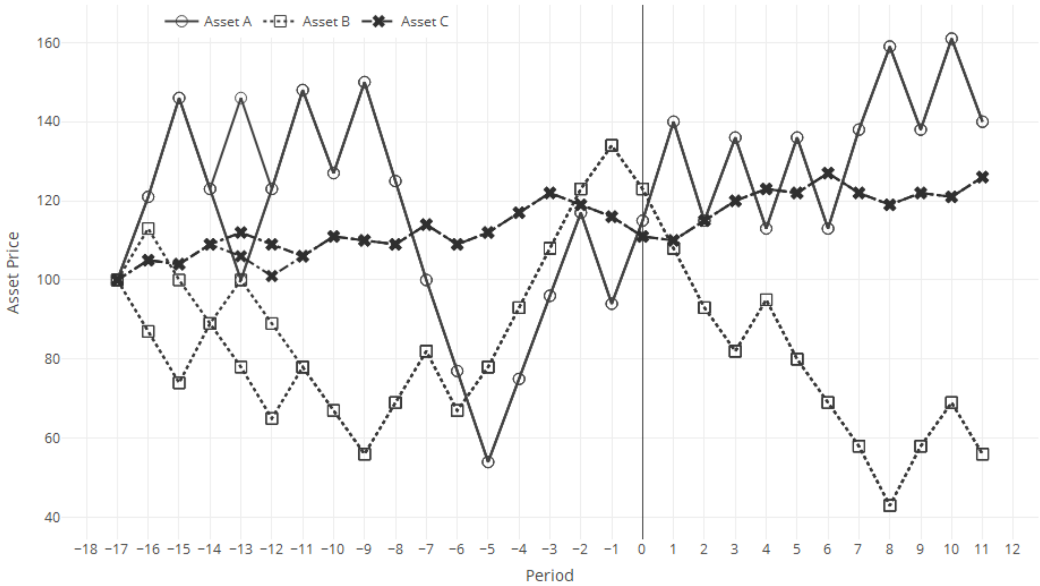
For each purchasing round in the first stage, the manipulation required two more rounds: one to change the prices and another one to reverse them. Although participants made a total of six decisions in the first stage, the first stage was composed of eighteen rounds (we used the sequence $(-17, -16, -15, -14, \cdots, 0)$. Purchases made in the first round (-17) under unadulterated prices had their outcomes shown in the next round (-16) under adulterated ones. Next, the program reversed these adulterations in the round (-15), and the participant could buy again only in period (-14) under unadulterated price, and so on.

The manipulation was deliberately set to increase the price by the same value when it would originally decrease and to invert this process soon after. However, the choice of how many and which assets would have prices changed was random to guarantee random influences in portfolio composition rather than intentional ones. The program manipulated randomly between assets to induce success properly.

We used this complex setup because the resulting series of manipulated prices preserves non-autocorrelation and apparent randomness of the outcomes, providing the appropriate environment for the formation of the hot hand belief whenever the frequency of success increases. This setup allowed an increase in the formation of the autocorrelation belief into the treatment II group before the second stage when all participants faced the original prices for ten following rounds with no manipulation and could be appropriately compared.

Our algorithm produced the prices series as expected, both the unadulterated and the manipulated prices presented approximately normal distribution, and our manipulation did not introduce any trend in the series. All of them presented $p-value$ above 0.05 in the Shapiro-Wilk normality test, implying that they were not significantly different from a normal distribution. Figure 1 shows the series used in the experimental sessions, a 'solid circle-open line' to asset A, a 'doted square-open line' to B and a 'dash-dotted ex line' to C. The first stage had two series to asset A and two series to asset C, one unadulterated and one manipulated, and four series to asset B, one unadulterated and three manipulated. Both the unadulterated and the manipulated price series were displayed using the same line type per asset. The two paths drawn by the 'doted square-open line' between the rounds −14 and −11 in Figure 1 show the difference between the unadulterated and the manipulated price series of the asset B in this range. The second stage (periods from 1 to 11) displayed only three unadulterated series naturally.

Figure 1 – Time series of asset prices used in the experiment



The procedure for obtaining the series of unadulterated prices was the same for all experiments. It is expected that participants were not previously aware of this because of the temporal and spatial separation of them. Appendix A fully describes the experiment protocols, including general rules, instructions, and consent forms.

2.4.1 Procedure

We run trials[6] to test the clarity of instructions on the computer screen and the participant's understanding of them as well as other design features. We created a third treatment group to test the condition that people are more willing to take risks on applications when they do not initially know the price generation process proposed by Barberis and Thaler (2003). Individuals in this group faced all parameters of the treatment I, but they were not informed about the price formation procedure using the highlight instructions (inside a rectangle) in Section A.2 from Appendix A. The instructor informed simply that the prices were randomly obtained from a draw and defined so that the asset

[6] Two Ethics Committee in Research approved the experiment, at the University of Brasilia under technicals advice No 2.558.540 and at the Federal University of Tocantins under No 2.850.741.

A had a high risk of loss and high risk of gain, B had a medium risk of loss and medium risk of gain, and C had a low risk of loss and low risk of gain.

All groups (treatment I, treatment II, and treatment I modified) had 14 undergraduate students from the Federal University of Tocantins (UFT) in the trials. Participants who knew the price distributions showed a significant difference in the average of assets purchased after the price had gone up in the previous period against when it had gone down. So, our final experimental design considered only the treatment I and the treatment II groups, both with a known distribution as in Weber and Camerer (1998). The trials also contributed to improve the game's instructions, evaluate the information set available in the game screen, and define the number of rounds.

Finally, we recruited two hundred twenty-six (226) undergraduate students at UFT and Faculty of Economics, Accounting and Administration (FACE) of the University of Brasília (UnB). The final sample contains only two hundred eight (208) people. We excluded eighteen (18) participants because they showed a gap in understanding the game. They reported that they could buy from only one asset or one unit each round. One hundred and six (106) students composed the treatment I group and one hundred two (102) the treatment II group. The experimental sessions were run from August 2018 to May 2019 at computer labs in both universities, with no more than 20 students available at the same time. Participants were positioned at spaced computers, and no conversation was allowed between them. A standard experimental session took approximately 30 minutes. The lowest and highest amount paid for participants were R$ 9.5 and R$ 11, respectively. The average value paid was R$ 10.

2.4.2 Hypotheses

The fundamental hypothesis tested was whether the hot hand effect was statistically significant. We computed two indexes that had an individual basis for evaluating their positive autocorrelation in the individual scale [See Weber and Camerer (1998, p.177)]. One of them (θ_1^i) was defined as the proportional difference between the quantities of assets purchased by the participant i after the price had gone up (U) and had gone down (D) in the previous period, $\theta_1^i = (U_i - D_i)/(U_i + D_i)$. Alternatively, we also defined a similar index (θ_2^i) considering the quantities of assets purchased after the participant had received a gain (G) or a loss (L) in the previous period, $\theta_2^i = (G_i - L_i)/(G_i + L_i)$.

We have $\theta_j^i = 1$ ($\theta_j^i = -1$) when all participant's purchases occurred after the price had gone up (gone down) in the previous period ($j = 1$), as well as when all participant's purchases occurred after receiving a gain (loss) in the last purchase ($j = 2$). Values close to 1 (-1) indicate a higher incidence of purchases following price increases or purchase gains (price reduction or purchase losses). The index hits 0 ($\theta_j^i = 0$) when the purchase amounts in these different purchase conditions are equal ($U = D$; $G = L$). So, there is no effect to $\theta_j^i \leq 0$, and the hot hand effect occurs when this coefficient is positive. Hypothesis 1 below tested these possibilities.

Hypothesis 1: $\overline{\theta}_j > 0$, with $j = \{1, 2\}$ and $\overline{\theta}_j$ is the average of the index values θ_j^i.

We also tested both the PT and how participants selected information analyzing how they evaluated gains/losses against some reference points. Our analysis used basic descriptive statistics because there was no influence of decisions on prices; prices were exogenously defined. The reference points were the purchase price (last price) and other historical benchmark levels, such as the average of recent prices and maximum prices [See Barberis, Huang and Santos (2001, p.13)]. Hypotheses 2, 3, and 4 tested if the participants decided to repurchase (hold) more assets comparing the current price to these benchmarks.

Hypothesis 2: (Purchase price reference point) the participant holds more assets when the actual price is above the purchase price than when the actual price is below;

Hypothesis 3: (Recent average price reference point) the participant holds more assets when the actual price is above the recent average price than when the actual price is below;

Hypothesis 4 (Maximum price reference point) the participant maintains more assets when the actual price is above the maximum price than when the actual price is below.

Complementarily, we also analyzed the purchase volume and the maintenance of a portfolio composition after favorable results. Hypothesis 5 below tested if a participant demonstrated a preference for the same portfolio after a sequence of successful results.

Hypothesis 5: a particular portfolio composition is selected/maintained more frequently after a sequence of successful results.

2.5 Results

The first hypothesis considers a simple analysis of average over the two indexes, θ_1^i and θ_2^i. The Shapiro-Wilk normality test shows that both these variables have distributions significantly different from a normal, returning a p-value < 0.01. Then, we used a nonparametric test for the difference of averages from zero. Table 2 shows the Wilcoxon signed-rank test with continuity correction for both indexes and considering the treatment I and the treatment II. We display the results of this test also considering five blocks of rounds: the first block considers all periods less than one (<1); three other blocks with three following rounds between the first and last round of the second stage (1-4;4-7;7-10), and another block with all rounds greater than one (1-10).

The averages of θ_1^i ($\overline{\theta}_1$) and θ_2^i ($\overline{\theta}_2$) were both positive and statistically different from zero in the first stage for the two treatments. The treatment I group has a value of approximately 0.1 ($\overline{\theta}_1 = \overline{\theta}_2 = 0.09$) and the treatment II group with $\overline{\theta}_1 = 0.46$ and $\overline{\theta}_2 = 0.47$. These results show participants purchasing proportionally more after an increase in prices (after receiving a gain) than after a decrease in prices (after receiving a loss), a behavior consistent with the hot hand belief. The average difference between treatment I and treatment II was statistically significant with p-value < 0.00 for both indexes in the first stage according to the nonparametric variance analysis by Pairwise Wilcoxon Test. Higher values in the treatment II group show a more strong propensity to purchase, suggesting that the manipulation produced a statistically significant increase in the 'hot behavior' as expected. This increase in the frequency of gain would not indicate endogenous effects over the belief formation since the manipulation of the price preserved the normal distribution and the apparent randomness, even though it could change variance.

Table 2 – Mean one-sample t-test for both indexes considering the treatment I group and the treatment II group

Rounds	$\overline{\theta}_1$			$\overline{\theta}_2$		
	Treatment I	Treatment II	All	Treatment I	Treatment II	All
< 1	0.09**	0.46***	0.27***	0.09**	0.47***	0.28***
	(0.78)	(0.62)	(0.73)	(0.78)	(0.63)	(0.73)
1-4	0.25***	0.31***	0.28***	0.31***	0.33***	0.32***
	(0.6)	(0.55)	(0.58)	(0.61)	(0.57)	(0.59)
4-7	-0.42***	-0.43***	-0.42***	-0.43***	-0.38***	-0.41***
	(0.56)	(0.58)	(0.57)	(0.56)	(0.63)	(0.6)
7-10	0.16***	0.13*	0.14***	0.13***	0.08*	0.11***
	(0.66)	(0.67)	(0.66)	(0.68)	(0.71)	(0.7)
1-10	-0.003	0.011	-0.001	-0.003	0.011	-0.007
	(0.68)	(0.68)	(0.68)	(0.7)	(0.7)	(0.7)

Note: $^{***}p \leq 0.01$, $^{**}p \leq 0.05$, $^{*}p \leq 0.1$ and standard deviation in parentheses.

Although we found no similar estimations of the hot hand effect involving portfolio selection and automatic sales in literature, this effect shows an opposing expectation of the disposition effect estimated by Weber and Camerer (1998). Both our design and the Weber and Camerer (1998) design have similarities that lead to a brief comparison. In this sense, our estimations involving the treatment I group in the first stage were a little less than their estimation of the disposition effect, 0.155. Our measures for the hot hand effect differ from the measures used by Hendricks, Patel and Zeckhauser (1993), Sundali and Croson (2006), and Huber, Kirchler and Stöckl (2010) because, while our indexes used the proportional differences between different purchase conditions, they considered mainly the frequency in which the investors have chosen the 'expert.'

The hot hand effect was also statistically significant at the beginning of the second stage for both treatment groups. However, surprisingly, it reverted and disappeared ($\overline{\theta}_j < 0$) between rounds (4-7) in both cases. The indexes were positive in the last block (7-10) even though smaller than in the first block of this stage, hitting zero when taking in to account all the second stage (1-10). They were also positively correlated between treatment groups through all the second stage, and, despite the treatment II group showed a strong effect in the first stage, the manipulation produced no average difference in the second one according to the nonparametric variance analysis by a Pairwise Wilcoxon Test. The participant who faced a manipulated price series presented a significant difference of averages in the first stage as expected, but this difference was not persistent in the second one. So, our subsequent analyses consider both the treatment I and the treatment II groups estimates as drawn from a single sample.

These first results indicate that the hot hand does not persist throughout the experiment, that even though the participant pursuits a pattern return by portfolio rebalancing, more profitable experiences in the past did not contribute to the belief formation. Although the effect fades away because of the declining propensity to buy, it is possible to show that this result was consistent with the PT prediction that investors are reluctant to realize losses, holding losing assets too long and selling winning ones too soon. The analysis of subsequent hypotheses showed that a persistent negative trend in the price of the asset B in the second stage supports the interpretation that a loss-averse investor works to balance his portfolio unwilling to realize losses.

Hypothesis 2 states that participants hold more assets when the actual price is above the purchase price than when it is below. Considering automatic sales, that suggests the person repurchased more assets when the price had gone up than when it had gone down. The purchase price is a reference point in this situation. Table 3 displays the total number of shares rebought depending on whether the price trend produces a gain or a loss in the last purchase. In general, results are similar to the conclusion from the first hypothesis.

Considering all the first stage and the first block of the second stage, overall individuals repurchased over 60% of the assets when they were facing gains against a number slightly under 40% when they were after losses. We consider this behavior compatible with our definition of the hot hand since individuals purchased consistently with an expectation that a favorable outcome was more likely after they got a gain. Although this pattern suggests the presence of hot hand beliefs, we found strong evidence of it only for the lower-risk asset (C), with around 90% of acquisitions made after a gain. The price of this asset was positive in almost every round of the first stage, with a slight decrease only after round (-3), as shown in Figure 1. The price trend of B was decreasing in the first part of the first stage but rose in the last one, while A performed the most significant price variation, as expected.

The proportion of purchases made after gains as well as of purchases made after losses show an ordering compatible with these different price variations. The aggregate purchase value of asset C was higher than the aggregate purchase value of asset B, and the aggregate purchase value of asset B was higher than the aggregate purchase value of asset A. This ordering shows that a more stable trend and more frequent gains were supporting the propensity to buy.

Table 3 – Total number of assets rebought depending on purchase price

	Rounds	A		B		C		Overall	
		Total	%	Total	%	Total	%	Total	%
Gain	<1	3522	40	4095	48	9475	89	17092	61
	1-4	969	30	1522	32	7037	100	9528	64
	4-7	1807	61	0	0	2117	35	3924	24
	7-10	1846	66	5765	57	1823	34	9434	52
	1-10	4622	51	7287	33	10977	59	22886	46
Loss	<1	5192	60	4354	52	1203	11	10749	39
	1-4	2247	70	3185	68	0	0	5432	36
	4-7	1151	39	7107	100	3973	65	12231	76
	7-10	958	34	4349	43	3515	66	8822	48
	1-10	4356	49	14641	67	7488	41	26485	54

These results show that our hot player increased his propensity to buy before positive price trends and decreased it before negative ones, but he demanded more prior evidence to support his optimistic and wrong judgment of positive autocorrelation. This pattern could explain the asset purchases through all stages but mainly to asset B between rounds (1-8). Acquisitions of B after losses in this range dominated the asset composition of the overall portfolio, evidence consistent with the hypothesis of a loss-averse investor unwilling to realize losses. Even the percentage of purchases after gains exceeding the percentage of purchases after losses at the end of the second stage (rounds 7-10), the excessive weighting of the losses from asset B seems to be the best explanation behind the missing effect in the second stage. While asset B had a proportion of purchases made after gains of 33% and purchases made after losses of 67%, these percentages were 51% and 49% to asset A, and 59% and 41% to asset C, respectively. Asset C exhibited more robust evidence of the hot hand belief in this sense.

A slightly different result emerged when we considered the total number of shares repurchased as a function of the price trend. Table 4 displays the same dominance of the purchase from asset B in the portfolio composition, but asset A also collaborated with the decline in the effect. The proportion of purchases of asset B made after a price increase was 33%, and after a price decrease was 67%, these percentages were 28% and 72% to asset A, respectively.

Table 4 – Total number of assets bought depending on the price trend

Trend	Rounds	A Total	A %	B Total	B %	C Total	C %	Overall Total	Overall %
+	<1	3704	38	4384	48	10133	89	18221	60
	1-4	1126	28	1783	33	7312	100	10221	61
	4-7	2161	55	0	0	2243	34	4404	24
	7-10	2287	67	6058	56	2141	36	10486	52
	1-10	5574	49	7841	33	11696	59	25111	45
-	<1	6039	62	4832	52	1267	11	12138	40
	1-4	2869	72	3600	67	0	0	6469	39
	4-7	1781	45	7776	100	4314	66	13871	76
	7-10	1103	33	4823	44	3880	64	9806	48
	1-10	5753	51	16199	67	8194	41	30146	55

We also compared the average gain obtained with assets that were purchased at any round but never again repurchased (called assets sold) with assets purchased anytime and rebought in every period after that until the end of the experimental session (called assets kept). In this context, the second hypothesis states that a hot hand player should keep assets with gains more than sell assets with losses, even though the LA works in the opposite direction. Table 5 shows that the average profit for assets sold was higher than for assets kept until the end of the second stage, R$ 3.6 and R$ -6.0, respectively. Again, our estimations suggest that the price trend of B was essential to reverse the effect. The average profit of B was negative when participants decided to keep R$ -21 or when they decided to sell R$ -12, but the former was almost double of the latter. The high incidence of failures in invest in asset B makes the participant more LA, motivating them to keep assets with losses in the hope of a reversal. Both assets A and C exhibited a positive average, considering assets kept or sold.

Table 5 – Average profit for assets sold anytime and kept until the end

	Rounds	A (R$)	B (R$)	C (R$)	Overall (R$)
Kept	<1	-20.9	14	13.6	7.7
	1-4	-35.0	-17	21.2	-12.4
	4-7	32.4	-50	-1.6	-12.9
	7-10	1.9	-2	4.9	3.9
	1-10	0.0	-21	7.8	-6.0
Sold	<1	-171.3	47	15.9	-54.1
	1-4	10.6	-51	18.0	-7.5
	4-7	38.0	-87	-10.8	-18.3
	7-10	-28.9	84	21.0	37.9
	1-10	9.3	-12	9.0	3.6

The assets purchased and not repurchased one or two periods after (called sales) reveal more details about the relation between LA and the hot hand effect. Table 6 displays the number of net sales in period t depending on whether prices increased or decreased in periods $t-1$ and $t-2$. That is, the number of assets sold that were not rebought immediately in period t depending on whether prices increased twice in two consecutive periods (UU), decreased and then increased (DU), increased and then decreased (UD), or decreased twice (DD). Sales should be lower when the price had gone up more times in the prior periods, according to hypothesis 2.

The results to the second stage show that changes in the price trend increased the willingness to sell, mainly when the price had gone up in the last period than when it had gone down. The percentage of assets sold at the price trend (DU) was 43.46% against 23.46% to the price trend (UD). The investor sold more before positive trends almost all the time, except in the block 4-7. Sales from periods after price increases (UU and DU) represent 58.95% of the aggregate sales, while after recent price decreases (UD and DD) fall to only 41.05%. However, participants also sold less often when faced with a positive sequence (UU) than a negative one (DD), 15.49%, and 17.59%, respectively. This result is consistent with the assumption that the hot hand player responded to the frequency of hits.

Table 6 – Number of sales in period t depending on whether prices increased or decreased in periods t_{-1} and t_{-2}

Rounds	Price Trend		Sales	Units Sold	%
	t_{-2}	t_{-1}			
<1	U	U	255	3294	32.39
	D	U	514	3916	38.50
	-	U	769	7210	70.89
	U	D	227	1571	15.45
	D	D	205	1390	13.67
	-	D	432	2961	29.11
1-4	U	U	169	1235	24.92
	D	U	220	2122	42.83
	-	U	389	3357	67.75
	U	D	147	773	15.60
	D	D	141	825	16.65
	-	D	288	1598	32.25
4-7	U	U	0	0	0.00
	D	U	282	2454	44.55
	-	U	282	2454	44.55
	U	D	305	2207	40.06
	D	D	109	848	15.39
	-	D	414	3055	55.45
7-10	U	U	125	1430	21.22
	D	U	212	2901	43.04
	-	U	337	4331	64.26
	U	D	157	1056	15.67
	D	D	164	1353	20.07
	-	D	321	2409	35.74
1-10	U	U	294	2665	15.49
	D	U	714	7477	43.46
	-	U	1008	10142	58.95
	U	D	609	4036	23.46
	D	D	414	3026	17.59
	-	D	1023	7062	41.05

These results indicate that the last price constitutes an inverted reference point associated with LA who effect is to attenuate the hot hand effect. We tested this argument using other potential reference points from the historical benchmark in hypotheses 3 and 4. These hypotheses consider the recent average price (maximum price) as a reference point, stating that the participant holds more shares when the actual price is above the recent average price (average price) than when the actual price is below it. Table 7 shows that people sold more after the price had gone up from average almost every block, except in block 7-10, 56.05% sold when faced an increase in price and 43.95% when faced a decrease in price. The same inverted reference point was not observed when we considered the maximum price. The sales pattern made at a current price smaller than the maximum price was very distinct from the pattern observed before. Above 90% of these sales occurred after a decrease in price, considering the second stage.

Table 7 – Number of sales in period t depending on whether prices increased or decreased relative to average price or maximum price in t_{-1}

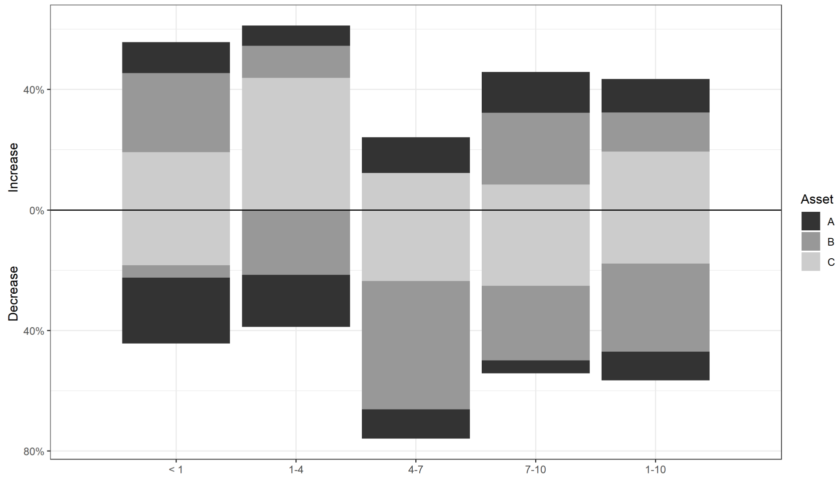
Rounds	Price Trend	Average			Maximum		
		Sales	Units Sold	%	Sales	Units Sold	%
<1	U	800	7341	72.18	153	926	10.47
	D	401	2830	27.82	884	7920	89.53
1-4	U	389	3357	67.75	26	209	4.71
	D	288	1598	32.25	580	4230	95.29
4-7	U	449	3762	68.29	21	219	4.35
	D	247	1747	31.71	617	4821	95.65
7-10	U	426	2962	43.95	31	250	4.31
	D	232	3778	56.05	483	5556	95.69
1-10	U	1264	10081	58.60	78	678	4.44
	D	767	7123	41.40	1680	14607	95.56

Note: The trend is relative to values from periods $< t$.

Finally, we tested if participants held on to a particular portfolio composition more frequently after a sequence of successful results than after a sequence of failures. Our hot hand player should observe the price trends and choose a portfolio such that he would short assets with negative price trends and high variance and long assets with successful results and low variance price streak. The investor should behave as whether 'success (failure) breeds success (failure).' Figure 2 shows the proportion of assets in portfolio composition considering the purchases made after the price had gone up (Increase) or gone down (Decrease) in the last period by blocks of rounds.

The first stage (< 1) and the first block of the second stage (1-4) exhibited choices compatible with the hot hand effect because most of the purchases occurred after price increases (bars above zero line) — in contrast with other blocks (bars below zero line). Asset C represents the most purchases in the block (1-4) (43.8%) when its price is positively autocorrelated against high variability of the stock A and a negative trend in the series of B. This percentage was only 10.7% to asset B and 6.7% to asset A. In contrast, almost 43% of all purchases between periods 4 and 7 refer to asset B, where its price had a negative trend. Here, purchases of B and C after losses account for two-thirds of all acquisitions. They represent almost 50% of all shopping from the last block (7-10) and all second stage, although B was preferred with 29.2% despite its more significant variability and negative price trend over periods. This tendency dominates the second stage and should explain the missing hot hand effect, being consistent with the presence of LA.

Figure 2 – Portfolio composition over the time



Alternatively, we analyzed the average of these investments in the assets using the Wilcoxon rank-sum test. This test showed that the average of purchases made after the price had gone up or gone down in the last period was significantly different throughout all blocks of rounds except to the block (1-10), in which only the asset C was significant. The proportion of the asset in the portfolio increased when its price trend was positive and reduced when a higher variance was observed. This result explains the inverted tendency between the proportion of assets A and C, considering price increases in the second stage. This dynamic between willing to sell or to buy affected by price increase and price decrease indicated how investors selected their portfolios compatible with a hot hand player, while LA guided the purchases of asset B.

2.6 Conclusions

We run a laboratory experiment with a hypothetical financial market to test the investor's belief that a streak of successful investments keeps this same trend in the next asset purchases even when the asset prices have a random formation. We assumed that the investor evaluates a self streak of outperformance differently compared when they choose an investment fund manager considering its past performance as well as choosing an 'expert' in a coin toss to predict the result of the next coin toss [Gilovich, Vallone and Tversky (1985), Hendricks, Patel and Zeckhauser (1993), Sirri and Tufano (1998) and Huber, Kirchler and Stöckl (2010)]. Our study considered the hot hand belief in the decision-maker base to isolate its direct effect on the portfolio selection and isolate its endogenous effects.

We used portfolio decisions about assets whose prices were generated from a random process in a way to define the belief in an autocorrelation as an unexpected judgment and independent from the price formation. Although considered a wrong expectation about the price formation, the hot hand belief was evaluated considering how the participants selected information about previous prices or even prior purchase performance such that the belief was also resulting from a representativeness error. Our experimental design used a new setup to the hot hand belief also as a strategy to attenuate ambiguity and familiarity of the participants about the diversity of the price distributions compared to other experimental designs [Sirri and Tufano (1998) and Huber, Kirchler and Stöckl (2010)].

The results show that the propensity to buy is, in part, positively correlated as prices move away from their last observed value in either direction. A higher frequency of success made the hot hand player show up in data, but the loss aversion effect dominated the portfolio management when the participant faced persistent negative price trends, making the hot hand effect fade away. However, the dynamics between willing to sell and willing to buy affected by the price movements or self unprofitable performances indicate an endogenous recomposition of the portfolio.

We reject the hypothesis that the hot hand effect was significantly different from zero. However, this result is consistent with our quasi-normative prediction that individuals are reluctant to realize losses. The right frequency of losses from asset B explains the reversion of the effect and its reduction to zero. Assets repurchased after a successful (unsuccessful) purchase or after the price had gone up (down) corroborates our hypothesis. In most cases, individuals behaved consistently with the hot hand belief considering the assets A and C in contrast with asset B. The acquisitions of asset B increased when we expected reductions, in contradiction with a hot hand investor facing successive losses. This behavior is even more evident when we look at sales and profits. Analysis of sales facing price going up or going down from the last price (the price average), as well as the profit of assets sold anytime and assets kept until the end, revealed that participants were willing to sell more profitable assets. This pattern is consistent with the hypothesis of a loss-averse investor unwilling to realize losses.

The average portfolio composition also showed how our investor moved away from being a hot hand player when he was facing losses to asset B, increasing the asset amount proportionally with recent losses and high variance while reducing after gains and before low variance. However, he revealed the expected pattern before A and C, increasing asset amount proportionally to the price increase frequency and reducing when a higher variance was observed. That explains the different tendencies in the portfolio composition when we compare the assets A and C with asset B.

Two features of our study corroborate the consistence of these conclusions. First, we improved the performance of a treatment group before they faced the unadulterated prices, and we observed they behaving, on average, similarly to individuals that had faced unadulterated prices. Our manipulation procedure improved success without generating trends in the price series, suggesting that it produced no endogeneity in belief formation. Although essential to improve gains, making some investors hotter, our manipulation did not eliminate LA when we compared both the unadulterated and adulterated price treatment groups. This result is evident in the pattern of the indexes used to estimate the hot hand effect, its positive correlation between groups, the absence of the average difference in the second stage of the game, also the declining propensity to buy overall assets.

The second reason why we consider our results to be consistent is that it is unlikely that we have overestimated the hot hand effect because automatic sales used in our experimental design should attenuate risk behavior [Weber and Camerer (1998)]. Moreover, a possible underestimation of the effect is not a problem here, because it would have preserved the conditions to evaluate the relationship between the hot-hand belief and LA.

Although experimental laboratory studies involve stylized conditions, the hot hand belief has been extensively documented in sports and finance [Bar-Eli, Avugos and Raab (2006), Sundali and Croson (2006), Huber, Kirchler and Stöckl (2010), Green and Zwiebel (2013) and Miller and Sanjurjo (2018)]. Besides, LA is a widely accepted behavioral phenomenon similarly documented in finance [Tversky and Kahneman (1991), Barberis and Thaler (2003), Haigh and List (2005) and Abdellaoui et al. (2016)]. In any case, it is worth noticing that our experiment used objective probabilities and that our sample also is not obtained from an entirely random sampling. Besides, we used a fixed endowment in order to eliminate bias like the Endowment and House Money effects, but may not be enough to eliminate influences from experience with lotteries, expectations regarding the experiment, or other imponderable components. Finally, we were unable to control for real incentive effects.

3 An MLA experimental study about feedback frequency and choice flexibility

3.1 Introduction

Myopic Loss Aversion (MLA) describes a 'myopic' behavior in which investors evaluate the individual return of assets in a portfolio rather than evaluating them together, and(or) evaluates them over a short time period [Benartzi and Thaler (1995)]. The combination of this behavior and Loss Aversion (LA) frequently causes losses such that the individual becomes more and more risk-averse. Consequently, the aggregation of results should reduce excessive risk aversion involving choice under uncertainty.

Several experiments have confirmed this attenuation using less-frequent feedback and controlling the flexibility of choice to induce aggregation [Gneezy and Potters (1997), Thaler et al. (1997), Haigh and List (2005) and Fernandes, Peña and Tabak (2006)]. This chapter tests the myopic loss aversion hypothesis using the changes proposed by Schoti (2012) to the experimental design of the Gneezy and Potters (1997) (GP). We evaluate the existence of a limit to the effect of aggregation on risk behavior. Results showed that MLA is positively related to the frequency of information about performance and positively related to the flexibility of choice. However, the effect of aggregation of information and choice over MLA is decreasing, revealing a nonlinear relationship between them.

GP compared the bets of two groups of students facing an independent but identical lottery throughout nine rounds[1]. One group was exposed to a high frequency of information (group H) and played the rounds one by one, in order to induce MLA. The other was exposed to a low frequency of information (group L) and played the rounds in blocks of three to limit MLA. People bet a smaller proportion of their endowment when they had more flexible choices and received more feedback about the results of the lotteries that they were playing. The design induced myopia and stimulated LA among the treatment group, causing greater risk aversion as predicted by Thaler (1999). Replication of this experiment also proved that aggregating over time or different asset categories reduces excessive risk aversion [see Haigh and List (2005) and Fernandes, Peña and Tabak (2006)].

Schoti (2012) introduced some innovations regarding previous studies to test how the risk-behavior changes when the frequency of feedback and flexibility of choice are smaller than what was provided to participants of previous experiments. The literature suggests that aggregation would tend to reduce the incidence of MLA, but does not make

[1] We are considering only nine of the twelve rounds that the authors used because they endowed the participants differently in rounds 10, 11, and 12.

the relation between them clear. Schoti's study replicates the original design from GP, but with a new treatment group in which students played the rounds in blocks of six to receive extremely low frequency of information (group E), further limiting MLA. In order to be able to perform this investigation, Schoti extended the number of rounds to eighteen rather than the traditional nine rounds used in previous studies and used a computer program created specifically for the experiment. This sped its implementation up and facilitated the execution of the eighteen rounds, preventing the participants from getting tired and preventing calculation errors.

We replicated the experimental design proposed by Schoti (2012), including her software and protocols, and get a representative sample. Our results show that the average bet by individuals from treatment L was statistically higher than values bet by participants of group H, but less than in group E, as expected. This result supports the finding of Benartzi and Thaler (1995) that it is possible to reduce excessive risk aversion by inducing aggregation of results. However, we found a disproportionate difference of percentages bet between L and H compared to E and L that refers to a limited effect of the aggregation. On average, aggregation increases the bet but in a relationship that is less than proportional to the restrictions. A concave function could well represent this decreasing effect over MLA.

This marginal decreasing influence of the aggregation over MLA could be explained by the learning mechanism in the individual betting strategies we observed. The average bet increased throughout rounds in line with the positive relationship between the expected value of the lottery and the bet amount. This result suggests that risk aversion decreases with the number of experiment repetitions. As this expected value is the same across treatments, reductions in the difference between the averages of the groups could also imply learning. Our analysis shows that the difference in the mean values between treatments reduces when the number of rounds increases, suggesting possible learning throughout the experiment and that a greater understanding of the game produces a lower incidence of MLA. However, this potential learning process is not sufficient to eliminate the incidence of myopia.

In addition to this introduction, Section 3.2 presents a literature review to MLA. Section 3.3 presents the experimental procedure, and the hypothesis tested (protocols are in Annex A). Section 3.4 describes the results and Section 3.5 concludes.

3.2 Myopic loss aversion

Prospect Theory (PT) states that people behave more sensitively after a loss than after a corresponding gain when they overestimate the likelihood of rare events that affect lottery payoffs. They also present opposite attitudes towards risk when choosing between lotteries whose payoffs lie in the positive and negative domains. This reversion occurs because individuals suffer from narrow framing when using mental accounting to evaluate gambles, so they focus on striking components of prospects while discarding regular ones [Thaler et al. (1980)]. Benartzi and Thaler (1995) used those preference patterns and this difficulty in gamble framing to define MLA for the first time. For these authors, MLA describes a situation in which the individual behaves unwillingly to take risks due to his loss-averse profile combined with the frequent evaluation of their performance.

Mental accounting is a psychological mechanism underlying the process of decision-making modeled by Kahneman and Tversky (1984) after Thaler et al. (1980) had highlighted its importance in consumer behavior. Through it, the individual evaluates advantageous and disadvantageous alternatives separately by mentally assigning a value from benchmarks, and then a decision-making process compares the options.

However, loss-averse agents do not follow neutral rules of aggregation since they evaluate portfolios differently with the change in the domain of returns. The decision-maker who pursues these rules, for instance, will reject an entire set of bets just because he evaluates the first gamble of this series as not profitable [Benartzi and Thaler (1995) and Thaler et al. (1997)]. That aggregation problem is naturally related to the frequency of these evaluations so that mental accounting tends to induce choices that focus on the short-term and a high incidence of feedbacks when past results are analyzed narrowly. Barberis and Huang (2001) argue that this may reflect a concern for non-consumption sources of utility, such as regret, which are often more naturally experienced over narrowly framed gains and losses.

The differentiation between the planning horizon (investment horizon) and the evaluation period characterizes the evaluation frequency. There can be several evaluation periods within the same planning horizon, but there may be a coincidence between them. In particular, the evaluation period influences the risk level to be assumed. An agent with an evaluation period smaller than the planning horizon acts as if they were similar, considering the variances of utility defined as changes in income or return as well as in the PT [Benartzi and Thaler (1995)]. Thus, the number of evaluations is directly proportional to changes in income, leading to an unwillingness to invest in high-risk assets.

The loss aversion degree depends on past returns, especially more recent ones. A loss after a gain produces less disutility than two consecutive losses. Then, the periodic evaluation of performance heightens people's aversion and produces myopia, which explains the agent preference for safe assets rather than risky ones with returns historically higher.

MLA was initially tested in a laboratory by Thaler et al. (1997) and GP. Thaler et al. (1997) observed a higher willingness to accept risks when investors evaluate their investments less often or when all payoffs remain in the positive domain. The investors with more frequent feedback took less risk and also earned less. Thus, a greater aggregation of information and a higher level of portfolio change restrictions yielded lower myopic effects.

GP evaluated individuals in a sequence of choices under reduced feedback conditions and limitations on betting changes. Their experiment had two parts and a total of twelve identical and independent rounds of a lottery that offered *a chance of 2/3 (67%) to lose the amount the individual bet and a chance of 1/3 (33%) to win two and a half times the amount he bet.* Although the probability of loss is higher than the probability gain, the expected value of that lottery is positive and equal to 1/6 of the bet. The first part of the experiment provided nine rounds in which each participant was endowed with 200 cents and could bet any amount (x_t) between 0 and 200 per round ($0 \leq x_t \leq 200, t = 1, 2, \cdots, 9$). So, each individual could use his amount accumulated in the first part to bet in the second one, 1/3 for each one of the last three periods (10,11,12).

The authors divided the participants into two groups, one with a high frequency of choice and feedback (Treatment H) and the other with a low frequency of choice and feedback (Treatment L). In every period, people in the former group chose to bet and then were informed if they had won or lost to induce MLA. They could change their bid in each round. Bets in the Treatment L were made in blocks of three rounds. The lottery results were reported together only at the end of each block. In round t, people decided how much of the endowment received in each round would be applied in rounds t, $t+1$, and $t+2$, reporting the lottery results together only at the end of the round $t+2$.

The results of the GP study suggested that individuals who receive information less often bet more since the average value of the bets of group H was statistically lower than in group L. The aggregation produced higher earnings and revealed individuals evaluating results over time under myopia and more sensitive for losses than gains.

Haigh and List (2005) (HL) extended the study conducted by GP to assess how the behavior of traders differ from nonprofessional investors. They compared a group of 54 professionals from the Chicago Board of Trade to a group of 64 graduate students. As in GP, both students and traders were divided into two distinct subgroups (H and L), but each participant was endowed with 100 units per round rather than 200 units. The authors assumed the hypothesis that the myopic loss aversion effect on choices about portfolio selection would be smaller for traders. Surprisingly, on average, traders exhibited MLA more accentuated than undergraduate students and also higher than the participants in the GP experiment. The difference between the average bet by traders of group H and group L is higher than among students in the HL compared to the GP experiment. Contrary to what was expected by the authors, training, experience, and specific knowledge of a particular market did not reduce the myopic loss aversion intensity. Recently, Larson, List and Metcalfe (2016) found evidence of MLA from natural experiments involving professionals in the market environment.

Fernandes, Peña and Tabak (2006) (FPT) followed closely the experiments conducted by GP and HL to compare MLA and house money effect[2] and evaluate which one was dominant involving bets on a lottery, which paid two and a half times the amount invested with one-third of probability and zero with two-thirds of probability. LA and house money effect have opposite effects on risk-behavior, while the former makes the investor sell soon earning assets, house money makes the investor keep them. The results showed that the MLA dominates the house money effect.

The literature documented many determinants to MLA, most of them primarily related to LA. MLA is associated with substitutability because the ownership of a good causes its owner to value it differently from a similar good in exchange. This attenuates the endowment effect[3] and displays MLA positively related with LA [Chapman (1998) and Carmon and Ariely (2000)]. The possession of an asset for less time reduces the LA effect in Strahilevitz and Loewenstein (1998). Kermer et al. (2006) showed that LA occurs because agents make wrong predictions about how they would feel if they have a loss, being impossible to avoid even by a learning process.

Empirical research also demonstrated the influence of the investment horizons and feedback frequency over MLA. Langer and Weber (2008) found that the period of commitment has a substantial impact and the feedback frequency a far less noticeable impact on decreasing myopia. Fellner and Sutter (2009) found that both variables, investment horizon and feedback frequency, contribute almost equally to the effects of MLA. Bellemare et al. (2005) showed that varying the information condition alone suffices to induce behavior according to the myopic loss aversion hypotheses. Sutter (2007) found that groups of investors are more willing to show MLA.

3.2.1 A new treatment

The GP, HL, and FPT studies corroborated the Thaler (1999) statement that *'the antidote for excessive risk aversion is aggregation, either across time or across different divisions'* [Thaler (1999, p. 201)]. Schoti (2012) collaborated with this debate evaluating the relationship between these variables under more aggregate conditions. Although the Schoti's sample did not reveal statistically significant results, the study suggested that risk aversion and aggregation are nonlinearly related, with a concave function representing this relationship.

In addition to the groups suggested by GP, Schoti (2012) proposed a third treatment group where the choices are maintained for six rounds. In t, individuals chose the bet that holds for rounds $(t, t+1, \cdots, t+6)$ and could not be either modified or results seen during

[2] Thaler and Johnson (1990) define house money effect as some circumstances where a prior gain can increase the subject's willingness to accept gambles.

[3] Thaler et al. (1980) defines the endowment effect as the fact that people often demand much more to give up an object than they would be willing to pay to acquire it.

this time. The results of these six rounds were reported together after the period $(t + 6)$. This new group had more aggregated results and less flexibility of choice to mitigate MLA even more.

The experimental design extended the number of rounds to eighteen rather than using the traditional nine periods of previous studies. The higher number of rounds allowed comparing the evolution of the mean bet for the groups with three and six round restriction and also to study learning throughout the experiment. This investigation also innovated using computers in the data collection to speed up the execution of the sessions, to prevent calculation errors and to enable the implementation of eighteen rounds rather than just nine, as in the first part of the experiment of GP. Table 8 compares the experiment proposed by Schoti (2012) with the GP, HL, and FPT experimental designs.

Table 8 – Cross features of the experimental designs

		GP	**HL**	**FPT**	**Schoti (2012)**
Treatment group	**H**:Feedback and choice flexibility (1 round)	X	X	X	X
	L:Feedback and choice flexibility (3 rounds)	X	X	X	X
	C:Feedback and choice flexibility (1 round). Bets in odd are made by (round's endowment + previous gain).			X	
	E:Feedback and choice flexibility (6 rounds)				X
	Rounds	12	12	12	18
	Material	Paper and pen	Paper and pen	Paper and pen	Computer
	Participant	Student	Student and traders	Student	Student
	Country	Netherlands	EUA	Brazil and Spain	Brazil
	Payment	US$0.6/round	Student(US$1/round) and Traders(US$4/round)	Brazil(R$1/round) and Spain(1 €/round)	R$0.5/round

3.3 Experimental design and procedures

Our experimental design follows Schoti (2012) exactly. We also used the same software and protocols used in her study to obtain a significantly-sized sample. The experiment had eighteen rounds where participants had to choose how much to bet in the lottery that offered *a chance of 2/3 (67%) of losing the amount the individual bet and a chance of 1/3 (33%) of winning two and a half times the amount.* Although the probability of loss is higher than the probability gain, the expected value of that lottery is positive and equal to 1/6 of the bet. Participants were divided into three groups with distinct rules for bets, groups H, L, and E. Groups H and L were formatted precisely as in GP, and the group E presented a more limited time frame for choices than prior experiments allowed.

People in group H received feedback about their bets after each round and could change their choices in all of them (18 decisions). Information about returns and the opportunity to play in group L were available every three rounds (6 choices in total). Participants in the group E received feedback every six rounds (information of all six returns was made available jointly after the six periods), and also the choice process was limited by the allocation of equal amounts in each block of bets (3 decisions in total, at $t = 1, t = 6$ and $t = 12$). This setup reduces the incidence of MLA in the group L compared to the group H, inducing lower average betting in the group H than in group L. For the same reason, the proportion of betting in group L would be lower than in group E.

Each participant received an endowment of 100 currency units in each round. Individuals from group H chose in each round the amount X of this endowment ($0 \leq X \leq 100$) they wished to bet in the lottery. They were informed about the probability distribution of the lottery and payoffs, and that in each round. Their payoffs would be 100 monetary units added to 2.5 times the bet amount in case of winning or 100 monetary units subtracted of the amount bet before a loss. When the participant lost, the bet amount X was deducted from the endowment (100 currency units), and the participant kept the remaining $(100 - X)$, but this balance could not be used on the next round. The participant received an additional endowment of 100 in the next round and could bet any amount X again, $(0 \leq X \leq 100)$. Similarly to prior studies, participants were allowed to bet only the endowment received in each round, although a total amount was accumulated throughout rounds.

Lottery results offered to the members of group L were identical to those provided in group H. However, the software automatically set the bets for the next three rounds (t, $t + 1$, and $t + 2$) after the participant's decision in t. Results of the lottery and the gains obtained were reported together after each block of three rounds. For instance, a participant who bet 100 currency units in t, also had this bet valid for $t + 1$ and $t + 2$, and it lost in t and $t + 1$, but won in $t + 2$, was simultaneously informed at $t + 3$ about the performance in each bet (0 in t, 0 in $t + 1$ and $100 + 2.5 \times 100$ in $t + 2$) and the aggregate result, an amount of 350 monetary units.

Finally, the participants in group E faced the same lottery as groups H and L. In this case, as in L, the choices were restricted and performed without immediate knowledge of their results. Instead of making their bets round after round, they determined in t their bets ($0 \leq X \leq 100$) for the rounds $(t, t + 1, \cdots, t + 5)$, where $X_t = X_{t+1} = X_{t+2} = X_{t+3} = X_{t+4} = X_{t+5}$. Results for each lottery and total amount obtained were reported together after each block of six rounds.

After each participant registered the amount he wished to bet, the software performed the draw and recorded the time he took to make the decision as well as his performance. The values gained in each round and the balance accumulated throughout the experiment were informed afterward, according to the group. The accumulated gain was the sum of the values won in each bet, being the gain per round a value between 0 to 350 currency units. The total return was paid in Brazilian Reais, so we set 100 monetary units equivalent to R$ 0.50 (US$ 0.12)[4]. The payment could vary from R$ 0.00 if the participant bets 100 currency units for all rounds and had only losses up to R$ 31.50 if he kept this same strategy but had only gains. Only a third of the participants in each session was randomly drawn to be entitled to payment.

We recruited 287 undergraduate students at the Federal University of Tocantins (UFT) from October 2018 to March 2019. The final sample contains only 269 participants since 18 participants were excluded because they took too little time in bet decision. Thus, 81 students received treatment H, 91 participate in group L, and 96 in treatment E. We performed 15 experimental sessions at a computer lab with approximately 20 students available at the same time. Participants were positioned at spaced terminals, and no conversation was allowed between them. The experiment instructions are in Section A.1 (Annex A).

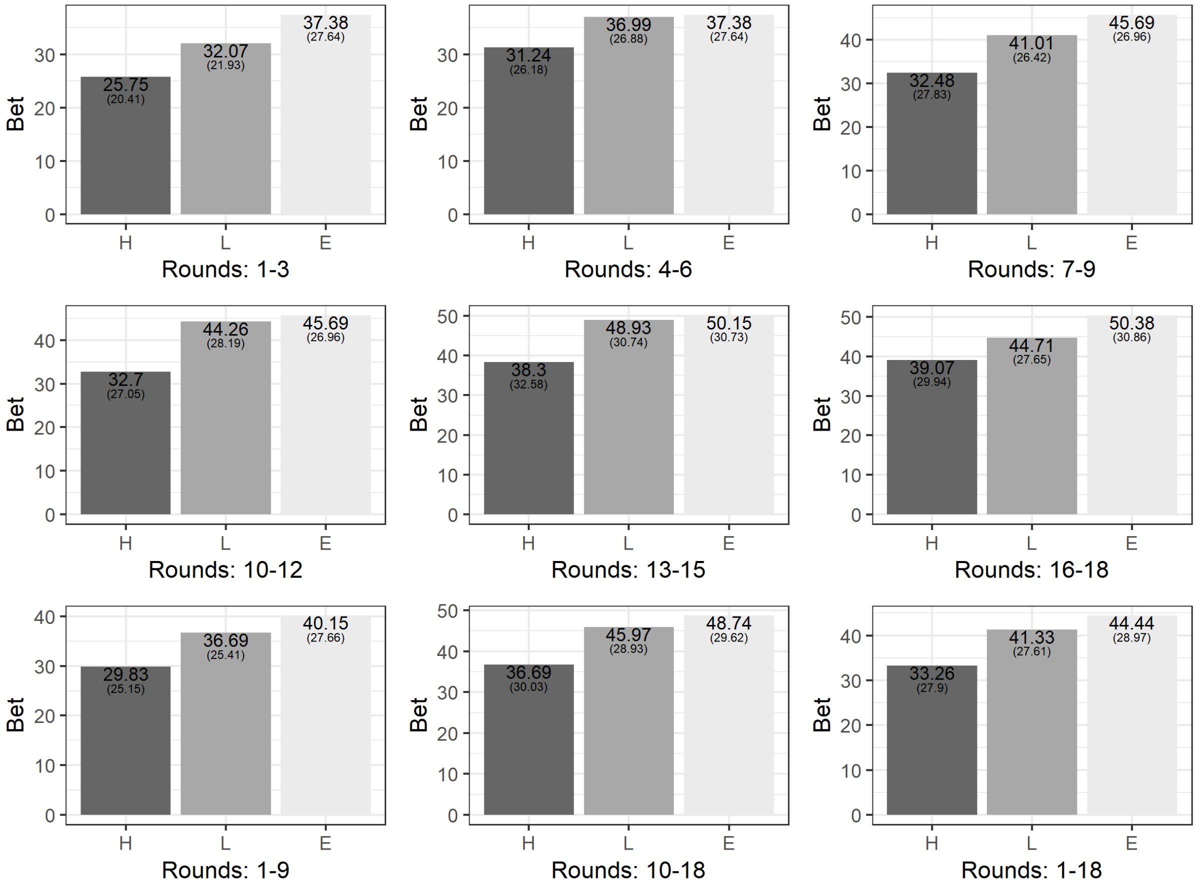
3.4 Results

Our analysis is similar to the one in GP. We compared the average percentages of the endowment (100 currency units) bet in the lottery by participants for groups of three rounds (1-3;4-6;7-9;10-12;13-15;16-18). We also compared these percentages clustering the periods in blocks of nine and overall (1-9;10-18;1-18). The difference between the averages bet reflects the myopic loss aversion effect in each group so that a higher difference indicates a stronger impact of MLA. Results are in Figure 3.

Participants bet on average more in group E than in groups L and H as well as bet on average more in group L than in group H. Considering all rounds, the proportion of the endowment bet was on average 44.44% in group E, 41.33% in group L and 33.26% in H. The percentage difference between L and H was higher than between E to L, showing that the bet increases on average when we limit feedbacks and choices but less than proportional to restrictions. Participants reinforced our hypothesis, exhibiting lower but disproportional risk aversion when faced with more limited information and choices. This result was observed throughout all blocks of rounds except for the last three rounds (16-18), where that percentage difference was slightly larger between groups E and L.

[4] One US dollar = 4,17 Reais on November 12, 2019, at 17:53 BACEN (2019).

Figure 3 – Comparing betting patterns



Note: Standard deviation (in brackets).

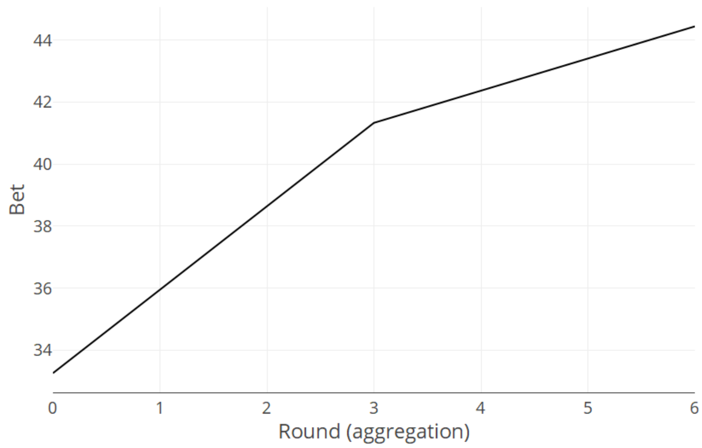
Figure 4 displays another test for this hypothesis using a simple quadratic regression $[bet = a(aggregation) + b(aggregation)^2 + c]$, where the value bet ($bet$) is a function of the number of rounds in which the information and the choice were limited ($aggregation$) but in quadratic terms. The coefficients of the model were all statistically significant at the 0.001 level. We predicted the piecewise line in Figure 4 using their values[5]. This result revealed an expected nonlinear relationship between aggregation and MLA. A concave function could be considered to represent this relation if a continuous set of restrictions was adopted.

The bet values were examined considering the Shapiro-Wilk normality test, which returned a p-value < 0.01 for all blocks of rounds. That indicates that their distribution is significantly different from a normal one. This is not a surprise since bet values are truncated by a lower bound (0) and an upper bound (100). Table 9 shows the nonparametric Wilcoxon Signed Rank Test with continuity correction to the pairwise comparison of treatment

[5] The values of c, a, and b were 39.98(98.68), 312.15(11.07) -81.57(-2.89), respectively with the standard errors in brackets.

groups and the Kruskal-Wallis Rank Sum Test for the difference of averages in all groups.

Figure 4 – Nonlinear regression to betting and aggregation of chores and results



The results of these tests show that the differences are statistically significant at 5% considering most blocks and group comparisons. No significance was observed only to the pairwise comparison LxE in blocks (1-3), (4-6), (10-12), and (13-15). That could suggest that the reduction of the frequency of information and the flexibility of choice between the L and E groups does not significantly affect the incidence of MLA.

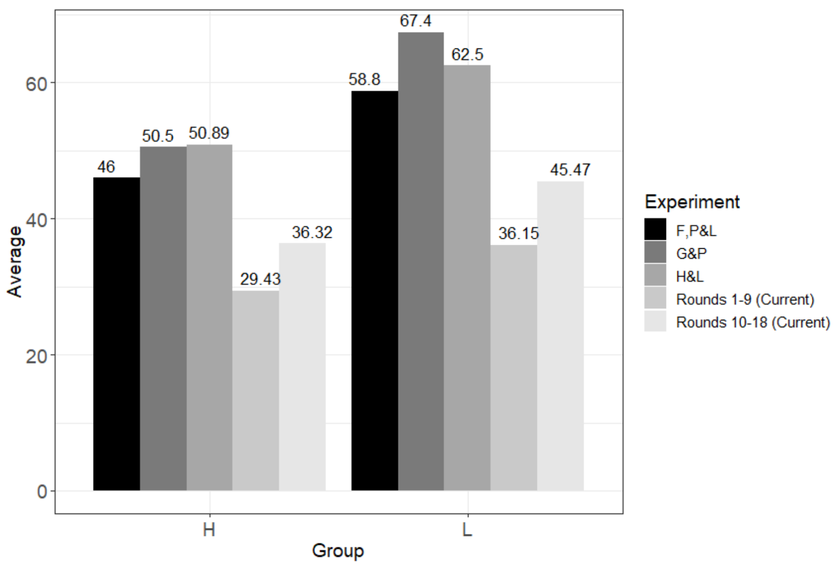
Table 9 – P-value from a nonparametric variance analysis

Rounds	HxL*	HxE*	LxE*	All**
1-3	0.000	0.000	0.150	0.000
4-6	0.004	0.003	0.853	0.001
7-9	0.000	0.000	0.039	0.000
10-12	0.000	0.000	0.440	0.000
13-15	0.000	0.000	0.590	0.000
16-18	0.008	0.000	0.038	0.000
1-9	0.000	0.000	0.028	0.000
10-18	0.000	0.000	0.049	0.000
1-18	0.000	0.000	0.003	0.000

Note: *Pairwise Wilcoxon rank sum test, **Kruskal-Wallis rank sum test.

We also compared the results from the first nine rounds of this experiment to the ones obtained by GP, HL, and FPT in Figure 5. Our results are consistent with previous studies regarding the trend of lower risk aversion for treatment L. On average, participants in group L bet 22.8% more than the participants in group H. In GP, HL, and FPT studies these values are 33%, 23%, and 27% respectively. However, the percentage of endowment bet by the participants of this study were lower than in these studies. This difference could be because our experiment was computer-based and not paper-based as other experiments. This imposes a greater dynamism in participation compared to when pen and paper were used to record the bets. Besides, results from FPT obtained with Brazilian students show a lower discrepancy in average bet when they are compared with students from other countries.

Figure 5 – Comparing the current average bet with previous studies



Allowing for more rounds in the game allowed us to analyze the learning mechanism in betting strategies. The evolution of average bets by rounds revealed participants were learning throughout the experiment, given that the expected value of the lottery indicates that they could earn more on average if they bet more. Figure 6 displays the increasing evolution of the average bet by blocks of three rounds. The increase in the percentage of the endowment bet between first and last blocks was 12.58% in group E, 12.64% in treatment L and 13.32% in H. That tendency suggests less myopic LA behavior along with the experiment.

Learning can also reduce the difference in the average bets between groups when participants experience more repetitions of the lottery because its expected value was the same between the different treatments. The decrease in these average differences suggests that the learning process tends to eliminate myopia. Figure 7 shows, in percentage terms, the change in the ratio of the average bets in the comparisons between the treatments E and H, E and L, and L to H. This ratio decreased from 45.13% in the first block of rounds to 28.95% in the last one in E/H comparison, 24.52% to 14.45% in E/L, and 16.56% to 12.67% in L/H, respectively. The difference in the mean values between treatments reduces when the number of rounds increases, suggesting a possible learning process throughout the experiment, and that participants' better understanding of the game produces a lower incidence of MLA. However, the difference was not eliminated in the eighteenth round. Our increase in the number of periods was not sufficient to completely neutralize the difference in bets.

Figure 6 – Evolution of average bets per rounds

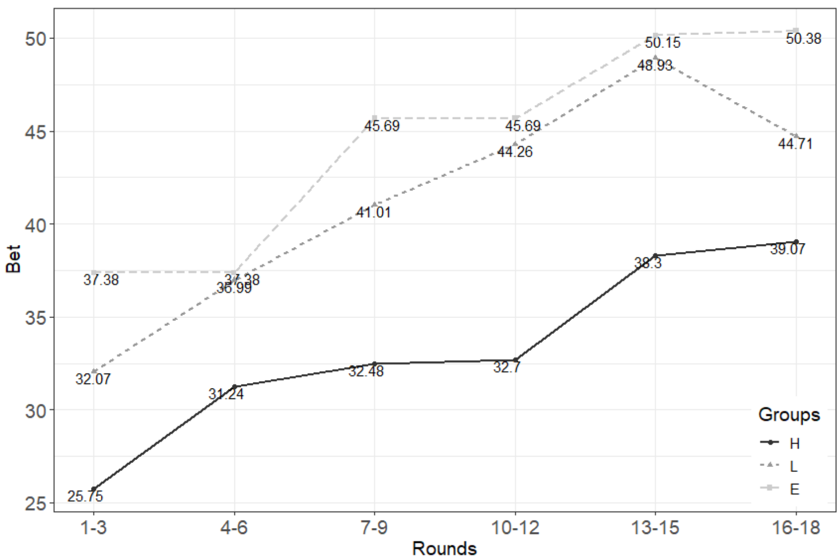
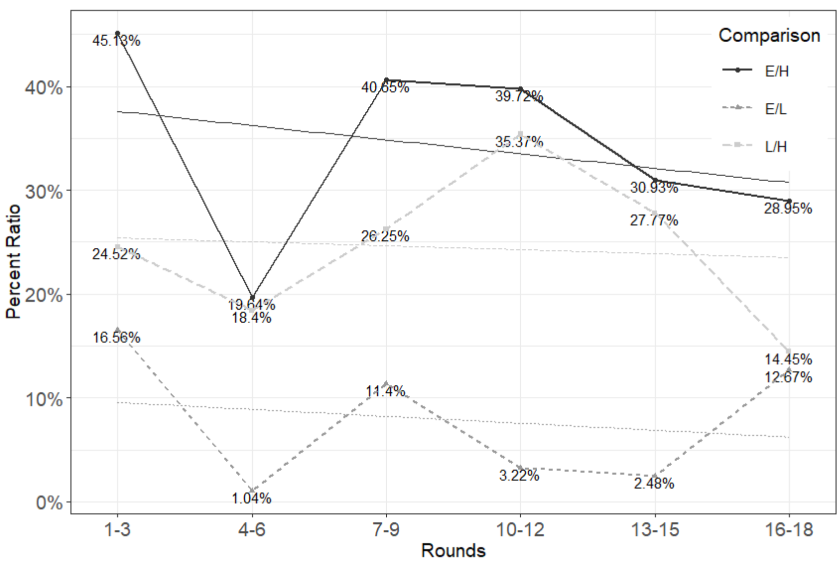


Figure 7 – Difference between the average bets by groups



3.5 Conclusion

We used experimental data to test the effect of aggregation of feedback about performance and limited choice flexibility on MLA, the phenomenon in which people display an unwillingness to assume risks due to the combination of LA and frequent performance evaluation. We used the experimental design from Schoti (2012) that expands the experiment designed by Gneezy and Potters (1997) and tested whether a higher level of aggregation in information and choice further mitigates the effects of MLA on the behavior of participants.

This design includes a third treatment group (group E), where the choice takes place only every six rounds, and results also are reported together after each block. We used a simple computer-based game programmed by Schoti (2012) with eighteen rounds rather than pen and paper throughout nine rounds, as in previous studies. Results show the presence of MLA, and that MLA is positively related to information frequency and flexibility of choice, that is, negatively associated with aggregation. However, doubling the restrictions on placing a bet and feedback did not produce twice less myopia, suggesting that the effect is not proportional.

As in prior experiments, the average bet by individuals from treatment L was statistically higher than the average bet by participants of group H but less than in group E. This suggests that participants tend to exhibit less myopia and bet more when facing more limited feedback and choices. This result also indicates the extent to which information inflexibility and limitation of information contribute to the reduction of excessive risk aversion, as proposed by Benartzi and Thaler (1995). However, the disproportional difference of percentages bet between L and H compared to E and L points to a limited effect of aggregation. On average, aggregation increases the number of currency units bet but less than proportional to the increase in the restriction. So, increasing aggregation has a decreasing effect on MLA.

A learning mechanism in individual betting strategies could partially explain the limited influence of the aggregation over MLA since the myopic effect was not entirely neutralized. Results show that the average bet increases throughout rounds in line with the positive relationship between the expected value of the lottery and the bet amount. This result suggests that risk aversion decreases as the number of game repetitions increases. As the expected value is the same across treatments, reductions in the difference between group averages could also imply learning. Our analysis shows that the difference in the mean values between treatments reduces when the number of rounds increases, suggesting possible learning throughout the experiment and that a greater understanding of the game produces a lower incidence of MLA, but still not enough to eliminate the incidence of a myopic behavior.

Finally, although experimental laboratory studies involve stylized conditions, many experimental works, and empirical investigations support our results. The importance of less frequent information feedback and freedom of choice for control risk aversion have extensive documentation in finance, as discussed in Section 3.2. Besides that, we are pointing out that the aggregation mechanism has a limited effect. In any case, it is worth noticing that our experiment uses objective probabilities. The investors spend much more than about thirty minutes to perform a similar amount of transaction in the market, and our sample also contains only students. We use a currency unit, and fixed endowment to eliminate bias like the Endowment and House Money Effect but may not be enough to eliminate influences from experience with lotteries, expectations regarding the experiment, or even imponderable components.

Part III

Conclusion

4 Conclusion

We use the Prospect Theory framework to addressing contributions to two finance themes: the hot hand belief and the effects of choice and feedback aggregation on MLA. We recruited undergraduate students to participate in experiments aimed to understand these two topics better. First, results showed that the hot hand belief endogenously affected portfolio management, but LA dominated this belief through persistent negative price trends. Second, the individual became more myopic when they faced with more frequent information and had more choice flexibility. However, doubling the restrictions on placing a bet and feedback about its performance did not produce two times less myopia, suggesting that the effect is not linear.

In the second chapter, we run a laboratory experiment with a hypothetical financial market to test the hot hand belief. Our experimental design considered its effect information-based and endogenous to the decision-maker. We used portfolio decisions about assets whose prices were generated from a random process in a way to define the belief in an autocorrelation as an unexpected judgment and independent from the price formation. Although considered a wrong expectation about the price formation, the hot hand belief was evaluated considering how the participants selected information about previous prices or even prior purchase performance such that the belief was also resulting from a representativeness error. We used this new setup to the hot hand belief also as a strategy to attenuate ambiguity and familiarity of the participants about the diversity of the price distributions compared to other experimental designs.

The results of the second chapter showed that the propensity to buy is positively correlated with prices. More frequent successes in investment decisions made the hot hand show up in data, but the loss-averse investor profile dominated the portfolio management when the participant faced a persistent negative price trend, making the effect fall away. Frequent gains could make investors 'hotter', but it did not eliminate LA. This pattern is supported by the loss-averse investor unwilling to realize losses. We concluded that the hot hand belief endogenously affects the portfolio selection, but LA can dominate it in some circumstances.

In the third chapter, we used the design experimental from Schoti (2012) to test limits for the effects of choice flexibility and feedback frequency on MLA. This design expands the experiment designed by Gneezy and Potters (1997), proposing a more aggregated information and choice design in a third group of participants to mitigate even more MLA. In this new treatment group, the choice takes place only every block of six rounds, and results also are reported together after each block. We used a simple computer-based game programmed by Schoti (2012) with eighteen rounds rather than pen and paper throughout nine rounds, as in previous studies.

The results of this chapter showed the presence of MLA and showed that MLA is positively related to information frequency and flexibility of choice, that is, negatively associated with aggregation. This suggests that participants tend to exhibit less risk aversion and bet higher amounts when they have less feedback and choices. However, doubling the restrictions on placing a bet and feedback did not produce two times less myopia, suggesting that the effect is not linear.

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Appendix

APPENDIX A – Experiment I

A.1 Regras gerais

Para participar do experimento, a pessoa tem de aceitar a política de privacidade da pesquisa assinando o Termo de Consentimento Livre e Esclarecido (TCLE) (Seção A.3) em duas vias. De acordo com ela, os dados armazenados serão usados para propósito limitado à elaboração de publicações e apresentações científicas, podendo ser compartilhados com instituições vinculadas unicamente dentro desse contexto. A participação no experimento é anônima no sentido de que os dados serão registrados de forma que não seja possível a posterior associação a qualquer participante.

Durante o experimento, cada participante terá que agir de acordo com as regras estabelecidas nas instruções gerais e específicas. As informações repassadas no âmbito individual devem seguir a mesma estrutura das instruções dadas coletivamente, devendo ser usados os mesmos termos e expressões. Quando não for possível um esclarecimento adicional, deve-se usar a frase: "a resposta a este questionamento ficará explícita ao longo do experimento".

A.2 Instruções

A.2.1 Gerais

Primeiramente, queremos destacar que:

1) Sua participação é anônima, pois não há nada no jogo que possa lhe identificar;

2) Você poderá ganhar dinheiro dependendo do seu desempenho e do sorteio que faremos ao final. 1/3 de vocês será sorteado para ficar com o dinheiro que ganharem no jogo.

3) Pedimos porém, que não fale com outro participante durante o experimento, mantendo seu desempenho em sigilo. Em caso de dúvida, você deverá solicitar a presença do instrutor levantando uma das mãos.

4) Ao final, pedimos que aguarde sentado(a). Quando todos os participantes concluírem, realizaremos o sorteio;

5) Após sua participação, solicitamos que não fale sobre detalhes do experimento com outras pessoas. Isso vai garantir que os futuros participantes se comportem com naturalidade e que a pesquisa seja bem-sucedida.

Nosso experimento é um jogo de investimento.

Nele, você receberá uma quantia fictícia de R$ 5.000,00 em cada rodada para escolher comprar de três ativos que têm retornos diferentes (A, B e C), podendo também manter esse recurso em dinheiro sem obter retorno.

Você poderá gastar esse recurso entre essas opções do modo que achar adequado.

Todos esses ativos tem preço inicial igual R$ 100,00.

Os preços seguintes não dependem das escolhas de nenhum de vocês, pois são obtidos a partir de um sorteio sem que ninguém saiba seu resultado antes de concluir a aposta.

Assim, as decisões de compra são tomadas sempre antes de se conhecer os preços futuros dos ativos.

Os preços futuros são definidos em dois passos:

1º) Para cada ativo, o programa sorteia se vai haver aumento ou redução de preço com 50% de chance cada;

2º) O programa sorteia o valor do aumento ou da redução entre três valores com iguais chances de ocorrência. Esses valores são 21, 23 e 25 para o ativo A; 11, 13 e 15 para o ativo B; e 1, 3 e 5 para o ativo C.

Os riscos de ganhar ou de perder são altos para o ativo A, médios para B e baixos para o ativo C.

Você possui algum questionamento até agora?

O jogo tem duas fases:

i Uma **fase inicial** onde você poderá fazer 6 decisões de compras para observar seu desempenho e acompanhar o comportamento dos preços.

  O desempenho obtido aqui não será considerado para fins de remuneração final.

ii E a **fase final** onde você poderá fazer 10 decisões de compras. Ao final, você receberá um percentual de 0,02% do total acumulado em dinheiro caso ele não seja negativo e você seja sorteado. O pagamento será realizado privadamente no final da sessão.

O jogo possui telas de instruções e de resultados que são de fácil entendimento. Ele também possui uma tela principal (Figura 8) que tem as seguintes partes:

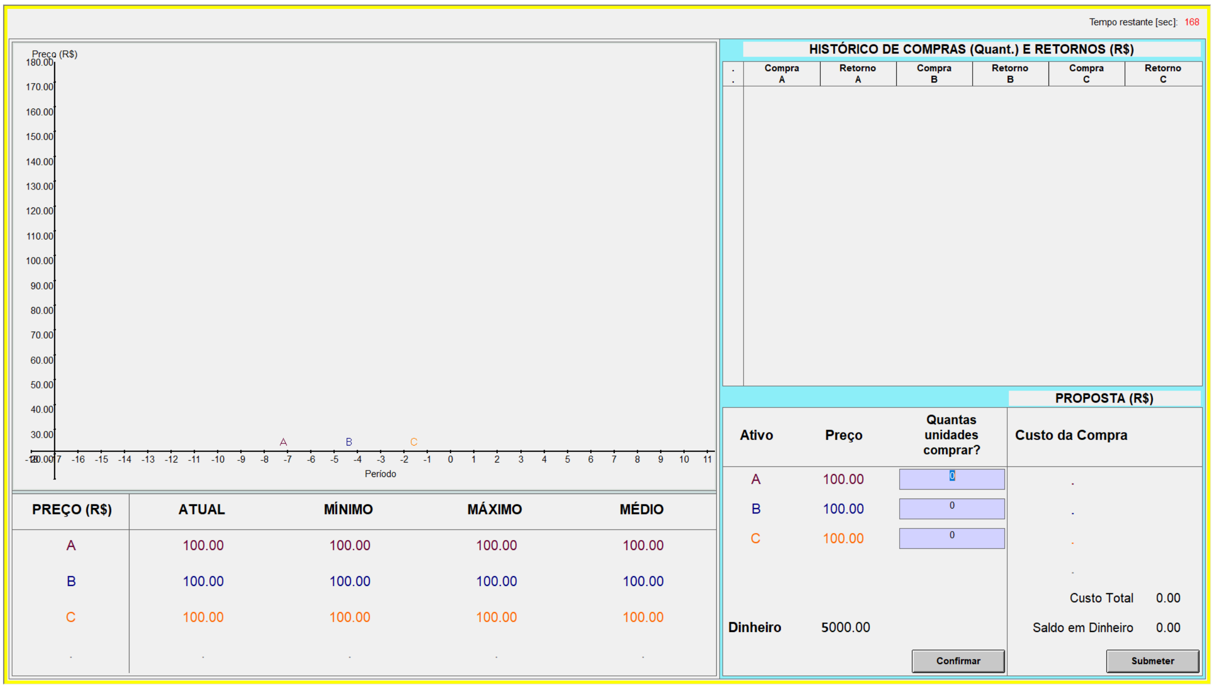
i Seu canto superior esquerdo tem um gráfico onde o preço de cada ativo será registrado rodada a rodada. Cada trajetória de preço é identificada com cores diferentes.

ii Logo abaixo, você encontra o preço atual, o preço mínimo, o preço máximo e o preço médio de cada ativo.

iii No canto superior direito, você visualiza o histórico das compras e se houve ganho ou perda em relação ao preço anterior de cada ativo.

iv Logo abaixo e à direita, temos seu montante em dinheiro e o local onde você poderá digitar a(s) quantidade(s) a ser(em) comprada(s). Após corretamente digitadas, você deve clicar em confirmar. Ao lado, aparecerá o custo de cada escolha e o total da proposta a ser submetida para concluir a transação.

Figure 8 – Main game screen



Você possui algum questionamento até agora?

Durante todo o jogo, você poderá observar as informações disponíveis para tentar prevê os preços seguintes e assim tomar sua decisão. Lembre-se que seu desempenho final depende de suas escolhas.

A.2.2 Específicas

1. Fase inicial:

Seja bem-vindo(a) à FASE INICIAL!

Leia as instruções abaixo com atenção!

Você receberá R$5.000,00 em cada uma das 6 rodadas desta fase para simular decisões de compras.

Esse recurso pode ser aplicado nos ativos (A, B e C) ou ser mantido em dinheiro sem rendimento.

O desempenho obtido aqui não será considerado para fins de remuneração final, mas você poderá observar SEU DESEMPENHO e acompanhar o COMPORTAMENTO DOS PREÇOS.

Clique em iniciar quando você concluir.

2. Fase final:

   Seja bem-vindo(a) à FASE FINAL!

   Leia as instruções abaixo com atenção!

   Você receberá R$5.000,00 em cada uma das 10 rodadas desta fase para decidir comprar quantidade(s) dos ativos (A, B e C) ou manter esse recurso em dinheiro sem rendimento.

   Lembre-se que os preços não dependem das escolhas de nenhum dos participantes, pois são definidos por um sorteio sem que ninguém saiba seu resultado antes de concluir a aposta.

   O desempenho obtido aqui será considerado para fins de remuneração. Caso seja sorteado(a), você receberá um percentual de 0,02% do saldo total destas rodadas se ele não for negativo.

   Clique em iniciar quando você concluir.

A.3 Termo de consentimento livre e esclarecido

UNIVERSIDADE DE BRASÍLIA
(DEPARTAMENTO DE ECONOMIA)
Termo de Consentimento Livre e Esclarecido (TCLE)

Convidamos o(a) Senhor(a) a participar voluntariamente do projeto de pesquisa economia experimental, sob a responsabilidade do pesquisador Marcleiton R. Morais. O projeto é parte do doutorado do pesquisador e objetiva fazer uso de experimento controlado em laboratório para investigar o comportamento individual diante de decisões financeiras de risco.

Compreender a tomada de decisão em ambiente de risco poderá melhor mapear os mecanismos a partir dos quais o comportamento dos agentes afeta os preços dos ativos nos mercados.

O(a) senhor(a) receberá todos os esclarecimentos necessários antes e no decorrer da pesquisa e lhe asseguramos que seu nome será mantido em sigilo pela omissão total de quaisquer informações que permitam identificá-lo(a).

A sua participação se dará por meio da atuação em um mercado simulado em computador, para realizar aplicações em uma série de ativos com diferentes riscos e retornos. A realização da sessão experimental tem um tempo estimado em 30 minutos.

Informamos que não foram identificados riscos associados à participação no experimento. Se você aceitar participar, estará contribuindo para o desenvolvimento da teoria econômica envolvendo escolha sob risco, podendo contribuir para o avanço da pesquisa.

O(a) Senhor(a) pode se recusar a responder qualquer questão que lhe traga constrangimento, podendo desistir de participar da pesquisa em qualquer momento sem nenhum prejuízo para o(a) senhor(a).

O(a) Sr(a) não terá nenhuma despesa relacionada diretamente à participação na pesquisa e ainda poderá receber remuneração a depender do seu desempenho no jogo. Caso haja algum dano direto ou indireto decorrente de sua participação na pesquisa, você poderá recorrer às disposições legais vigentes no Brasil.

Os resultados da pesquisa serão divulgados na Universidade de Brasília - UnB podendo ser publicados posteriormente. Os dados e materiais serão utilizados somente para esta pesquisa e ficarão sob a guarda do pesquisador por um período de cinco anos.

Se o(a) Senhor(a) tiver qualquer dúvida em relação à pesquisa, por favor telefone para: Marcleiton R. Morais, telefone 63-99206-9236, ou envie e-mail para: *mrm@uft.edu.br*.

Este projeto foi aprovado pelo Comitê de Ética em Pesquisa em Ciências Humanas e Sociais (CEP/CHS) da UnB. O CEP é composto por profissionais de diferentes áreas cuja função é defender os interesses dos participantes da pesquisa em sua integridade e dignidade e contribuir no desenvolvimento da pesquisa dentro de padrões éticos. As dúvidas com relação à assinatura do TCLE ou os direitos do participante da pesquisa podem ser esclarecidos pelo telefone (61) 3107-1592 ou do e-mail do CEP/CHS: *cep_chs@unb.br*.

Caso concorde em participar, pedimos que assine este documento que foi elaborado em duas vias, uma ficará com o pesquisador responsável e a outra com o Senhor(a).

______________________________	______________________________
Assinatura do participante	**Marcleiton Ribeiro Morais** Pesquisador responsável

Brasília ________, de ________, de 2019.

Annex

ANNEX A – Experiment II

A.1 Instruções

A.1.1 Tratamento H

Bem vindo ao estudo experimental sobre escolhas sob incerteza.

Sua participação é anônima. A partir de agora, sempre que seu nome for solicitado, você poderá usar o número que está no canto inferior direto do TCLE.

O experimento deverá levar cerca de 30 min. Suas instruções são simples, se você acompanhá-las atentamente você poderá ganhar uma quantia considerável de dinheiro. Todo o dinheiro que você acumular durante o jogo poderá ser seu ao final do experimento. Basta aguardar em silêncio até que todos os participantes concluam e 1/3 de vocês será sorteado para ficar com o dinheiro acumulado.

É muito importante que você não se comunique com outros participantes durante o experimento. Em caso de dúvida, você deverá solicitar a presença do instrutor levantando uma das mãos.

O experimento consiste de 19 rodadas consecutivas de uma mesma loteria, sendo que a primeira será apenas teste e não vale nada. Assim, você jogará efetivamente 18 rodadas. *Em cada uma das rodadas você receberá a quantia de 100 unidades monetárias (u.m.)* e deverá decidir que valor deste montante (entre zero e 100 u.m.) você deseja apostar na seguinte loteria:

Você tem dois terços de chance (67%) de perder a quantidade que você escolher apostar e um terço de chance (33%) de vencer 2,5 vezes o valor que você apostar.

Em todas as 18 rodadas você deverá digitar sua escolha no local indicado pelo programa e confirmar sua escolha. Assim, você poderá escolher em cada rodada quanto deseja apostar na loteria.

Ganhar ou perder a loteria dependerá da sua letra de registro. Você poderá escolher esta letra no início do jogo, quando indicado pelo programa. Sua letra de registro poderá ser A, B ou C, e será a mesma para as 18 rodadas. Em qualquer rodada você vencerá a loteria se sua letra de registro for igual à letra sorteada na rodada, que será sorteada aleatoriamente pelo programa. Você perderá a loteria se sua letra de registro for diferente da letra da rodada.

A letra da rodada é determinada aleatoriamente e cada uma delas tem 1/3 de chance de ocorrer, ou seja, 33%. Após escolher e confirmar sua aposta, o programa fará o sorteio da letra da rodada. A letra selecionada é a letra da rodada para aquela rodada apenas. Como existem três letras, sendo que uma delas e igual à sua letra de registro, a probabilidade de vencer a loteria é de 1/3 (33%) e a probabilidade de perder é de 2/3 (67%).

Seus ganhos na loteria são determinados como segue. Se você apostar X u.m. na loteria e ganhar, então você ganhara 2,5 vezes X mais as 100 u.m. que recebeu no início da rodada. Assim, se você apostar 10 u.m. e ganhar, seu ganho total na rodada será de 125 u.m.. Se você perder, perderá as X u.m., mas ficará com o que restou das 100 u.m. que recebeu. Assim, se apostar 10 u.m. e perder, você perderá 10, mas ainda ficará com 90 u.m.. Na rodada seguinte você receberá 100 u.m. novamente. O programa lhe informará sobre o ganho na loteria, o ganho total da rodada (ganho ou perda na loteria mais 100 u.m.) e o valor acumulado em todas as rodadas.

Cada duas unidades monetárias representa um centavo (2 u.m. = 1 centavo de real).

Lembre-se: sua letra de registro é sempre a mesma, mas a letra da rodada pode mudar a cada sorteio. Todas as rodadas subsequentes serão realizadas da mesma maneira.

Após a última rodada ter sido completada, seus ganhos em todas as rodadas serão somados. Essa quantia determina o valor total a que você irá concorrer ao final do experimento. Pedimos que o anote no TCLE.

A.1.2 Tratamento L

Bem vindo ao estudo experimental sobre escolhas sob incerteza.

Sua participação é anônima. A partir de agora, sempre que seu nome for solicitado, você poderá usar o número que está no canto inferior direto do TCLE.

O experimento deverá levar cerca de 30 min. Suas instruções são simples, se você acompanhá-las atentamente você poderá ganhar uma quantia considerável de dinheiro. Todo o dinheiro que você acumular durante o jogo poderá ser seu ao final do experimento. Basta aguardar em silêncio até que todos os participantes concluam e 1/3 de vocês será sorteado para ficar com o dinheiro acumulado.

É muito importante que você não se comunique com outros participantes durante o experimento. Em caso de dúvida, você deverá solicitar a presença do instrutor levantando uma das mãos.

O experimento consiste de 19 rodadas consecutivas de uma mesma loteria, sendo que a primeira será apenas teste e não vale nada. Assim, você jogará efetivamente 18 rodadas. *Em cada uma das rodadas você receberá a quantia de 100 unidades monetárias (u.m.)* e deverá decidir que valor deste montante (entre 0 e 100 u.m.) você deseja apostar na seguinte loteria:

Você tem dois terços de chance (67%) de perder a quantidade que você escolher apostar e um terço de chance (33%) de vencer 2,5 vezes o valor que você apostar.

Você realizará suas escolhas a cada três rodadas e os valores definidos para cada bloco de três serão os mesmos. Por exemplo, suponha que você deseje apostar 10 u.m. na rodada 1, isso significa que você terá escolhido apostar 10 u.m. também nas rodadas 2 e 3. LEMBRE-SE, uma vez escolhido o valor para a rodada 1, você não poderá alterá-lo para as rodadas 2 e 3. Essa regra valerá para as rodadas 4-5-6, 7-8-9 e assim por diante, ate a rodada 18.

O programa lhe informará a rodada que você está jogando. Quando indicado, digite o valor escolhido e confirme sua escolha.

Ganhar ou perder a loteria dependerá da sua letra de registro. Você poderá escolher esta letra no início do jogo, quando indicado pelo programa. Sua letra de registro poderá ser A, B ou C, e será a mesma para as 18 rodadas. Em qualquer rodada você vencerá a loteria se sua letra de registro for igual à letra sorteada na rodada, que será sorteada aleatoriamente pelo programa. Você perderá a loteria se sua letra de registro for diferente da letra da rodada.

A letra da rodada é determinada aleatoriamente pelo programa. Após escolher e confirmar sua aposta, *o programa fará o sorteio da letra da rodada vigente e das DUAS seguintes*. A letra selecionada é a letra da rodada para aquela rodada apenas. Como existem três letras, sendo que uma delas é igual à sua letra de registro, a probabilidade de vencer a loteria é de 1/3 (33%) e a probabilidade de perder é de 2/3 (67%).

Seus ganhos na loteria são determinados como segue. Se você apostar X u.m. na loteria e ganhar, então você ganhará 2,5 vezes X mais as 100 u.m. que recebeu no início da rodada. Assim, se você apostar 10 u.m. e ganhar, seu ganho total na rodada será de 125 u.m.. Se você perder, perderá as X u.m., mas ficará com o que restou das 100 u.m. que recebeu. Assim, se apostar 10 u.m. e perder, você perderá 10, mas ainda ficará com 90 u.m.. Na rodada seguinte você receberá 100 u.m. novamente. O programa lhe informará sobre o ganho na loteria, o ganho total da rodada (ganho ou perda na loteria mais 300 u.m.) e o valor acumulado em todas as rodadas.

Cada duas unidades monetárias representam um centavo (2 u.m. = 1 centavo de real).

Lembre-se: sua letra de registro é sempre a mesma, mas a letra da rodada pode mudar a cada sorteio. Todas as rodadas subsequentes serão realizadas da mesma maneira.

Após a última rodada ter sido completada, seus ganhos em todas as rodadas serão somados. Essa quantia determina o valor total a que você irá concorrer ao final do experimento. Pedimos que o anote no TCLE.

A.1.3 Tratamento E

Bem vindo ao estudo experimental sobre escolhas sob incerteza.

Sua participação é anônima. A partir de agora, sempre que seu nome for solicitado, você poderá usar o número que está no canto inferior direto do TCLE.

O experimento deverá levar cerca de 30 min. Suas instruções são simples, se você acompanhá-las atentamente você poderá ganhar uma quantia considerável de dinheiro. Todo o dinheiro que você acumular durante o jogo poderá ser seu ao final do experimento. Basta aguardar em silêncio até que todos os participantes concluam e 1/3 de vocês será sorteado para ficar com o dinheiro acumulado.

É muito importante que você não se comunique com outros participantes durante o experimento. Em caso de dúvida, você deverá solicitar a presença do instrutor levantando uma das mãos.

O experimento consiste de 19 rodadas consecutivas de uma mesma loteria, sendo que a primeira será apenas teste e não vale nada. Assim, você jogará efetivamente 18 rodadas. Em cada uma das rodadas você receberá a quantia de 100 unidades monetárias (u.m.) e deverá decidir que valor deste montante (entre 0 e 100 u.m.) você deseja apostar na seguinte loteria:

Você tem dois terços de chance (67%) de perder a quantidade que você escolher apostar e um terço de chance (33%) de vencer 2,5 vezes o valor que você apostar.

Você realizará suas escolhas a cada SEIS rodadas e os valores definidos para cada bloco de SEIS serão os mesmos. Por exemplo, suponha que você deseje apostar 10 u.m. na rodada 1, isso significa que você terá escolhido apostar 10 u.m. também nas rodadas 2,3,4,5 e 6. LEMBRE-SE, uma vez escolhido o valor para a rodada 1, você não poderá alterá-lo para as rodadas 2,3,4,5 e 6. Essa regra valerá para as rodadas 7-8-9-10-11-12 e 13-14-15-16-17-18.

O programa lhe informará a rodada que você está jogando. Quando indicado, digite o valor escolhido e confirme sua escolha.

Ganhar ou perder a loteria dependerá da sua letra de registro. Você poderá escolher esta letra no início do jogo, quando indicado pelo programa. Sua letra de registro poderá ser A, B ou C, e será a mesma para as 18 rodadas.

Em qualquer rodada você vencerá a loteria se sua letra de registro for igual à letra sorteada na rodada, que será sorteada aleatoriamente pelo programa. Você perderá a loteria se sua letra de registro for diferente da letra da rodada.

A letra da rodada é determinada aleatoriamente pelo programa. Após escolher e confirmar sua aposta, *o programa fará o sorteio da letra da rodada vigente e das CINCO seguintes*. A letra selecionada é a letra da rodada para aquela rodada apenas. Como existem três letras, sendo que uma delas e igual a sua letra de registro, a probabilidade de vencer a loteria é de 1/3 (33%) e a probabilidade de perder é de 2/3 (67%).

Seus ganhos na loteria são determinados como segue. Se você apostar X u.m. na loteria e ganhar, então você ganhará 2,5 vezes X mais as 100 u.m. que recebeu no início da rodada. Assim, se você apostar 10 u.m. e ganhar, seu ganho total na rodada será de 125 u.m.. Se você perder, perderá as X u.m., mas ficará com o que restou das 100 u.m. que recebeu. Assim, se apostar 10 u.m. e perder, você perderá 10, mas ainda ficará com 90 u.m.. Na rodada seguinte você receberá 100 u.m. novamente. O programa lhe informará sobre o ganho na loteria, o ganho total da rodada (ganho ou perda na loteria mais 600 u.m.) e o valor acumulado em todas as rodadas.

Cada duas unidades monetárias representam um centavo (dois u.m. = 1 centavo de real).

Lembre-se: sua letra de registro é sempre a mesma, mas a letra da rodada pode mudar a cada sorteio. Todas as rodadas subsequentes serão realizadas da mesma maneira.

Após a última rodada ter sido completada, seus ganhos em todas as rodadas serão somados. Essa quantia determina o valor total a que você irá concorrer ao final do experimento. Pedimos que o anote no TCLE.

A.2 Termo de consentimento livre e esclarecido

UNIVERSIDADE DE BRASÍLIA
(DEPARTAMENTO DE ECONOMIA)
Termo de Consentimento Livre e Esclarecido (TCLE)

Convidamos o(a) Senhor(a) a participar voluntariamente do projeto de pesquisa economia experimental, sob a responsabilidade do pesquisador Marcleiton R. Morais. O projeto é parte do doutorado do pesquisador e objetiva fazer uso de experimento controlado em laboratório para investigar o comportamento individual diante de decisões financeiras de risco.

Compreender a tomada de decisão em ambiente de risco poderá melhor mapear os mecanismos a partir dos quais o comportamento dos agentes afeta os preços dos ativos nos mercados.

O(a) senhor(a) receberá todos os esclarecimentos necessários antes e no decorrer da pesquisa e lhe asseguramos que seu nome será mantido em sigilo pela omissão total de quaisquer informações que permitam identificá-lo(a).

A sua participação se dará por meio do uso de um programa de computador, para realizar aplicações em uma loteria fazendo uso de recursos monetários fictícios. A realização da sessão experimental tem um tempo estimado em 30 minutos.

Informamos que não foram identificados riscos associados à participação no experimento. Se você aceitar participar, estará contribuindo para o desenvolvimento da teoria econômica envolvendo escolha sob risco, podendo contribuir para o avanço da pesquisa.

O(a) Senhor(a) pode se recusar a responder qualquer questão que lhe traga constrangimento, podendo desistir de participar da pesquisa em qualquer momento sem nenhum prejuízo para o(a) senhor(a).

O(a) Sr(a) não terá nenhuma despesa relacionada diretamente à participação na pesquisa e ainda poderá receber remuneração ao final da sessão. Caso haja algum dano direto ou indireto decorrente de sua participação na pesquisa, você poderá recorrer às disposições legais vigentes no Brasil.

Os resultados da pesquisa serão divulgados na Universidade de Brasília - UFT podendo ser publicados posteriormente. Os dados e materiais serão utilizados somente para esta pesquisa e ficarão sob a guarda do pesquisador por um período de cinco anos.

Se o(a) Senhor(a) tiver qualquer dúvida em relação à pesquisa, por favor telefone para: Marcleiton R. Morais, telefone 63-99206-9236, ou envie e-mail para: *mrm@uft.edu.br*.

Este projeto foi aprovado pelo Comitê de Ética em Pesquisa em Ciências Humanas e Sociais (CEP/CHS) da UnB. O CEP é composto por profissionais de diferentes áreas cuja função é defender os interesses dos participantes da pesquisa em sua integridade e dignidade e contribuir no desenvolvimento da pesquisa dentro de padrões éticos. As dúvidas com relação à assinatura do TCLE ou os direitos do participante da pesquisa podem ser esclarecidos pelo telefone (61) 3107-1592 ou do e-mail do CEP/CHS: *cep_chs@unb.br*.

Caso concorde em participar, pedimos que assine este documento que foi elaborado em duas vias, uma ficará com o pesquisador responsável e a outra com o Senhor(a).

____
Assinatura do participante

____
Marcleiton Ribeiro Morais
Pesquisador responsável

Brasília _________, de _________, de 2019.