Cognitive Biases: Empirical evidences from a Stock Market Simulation

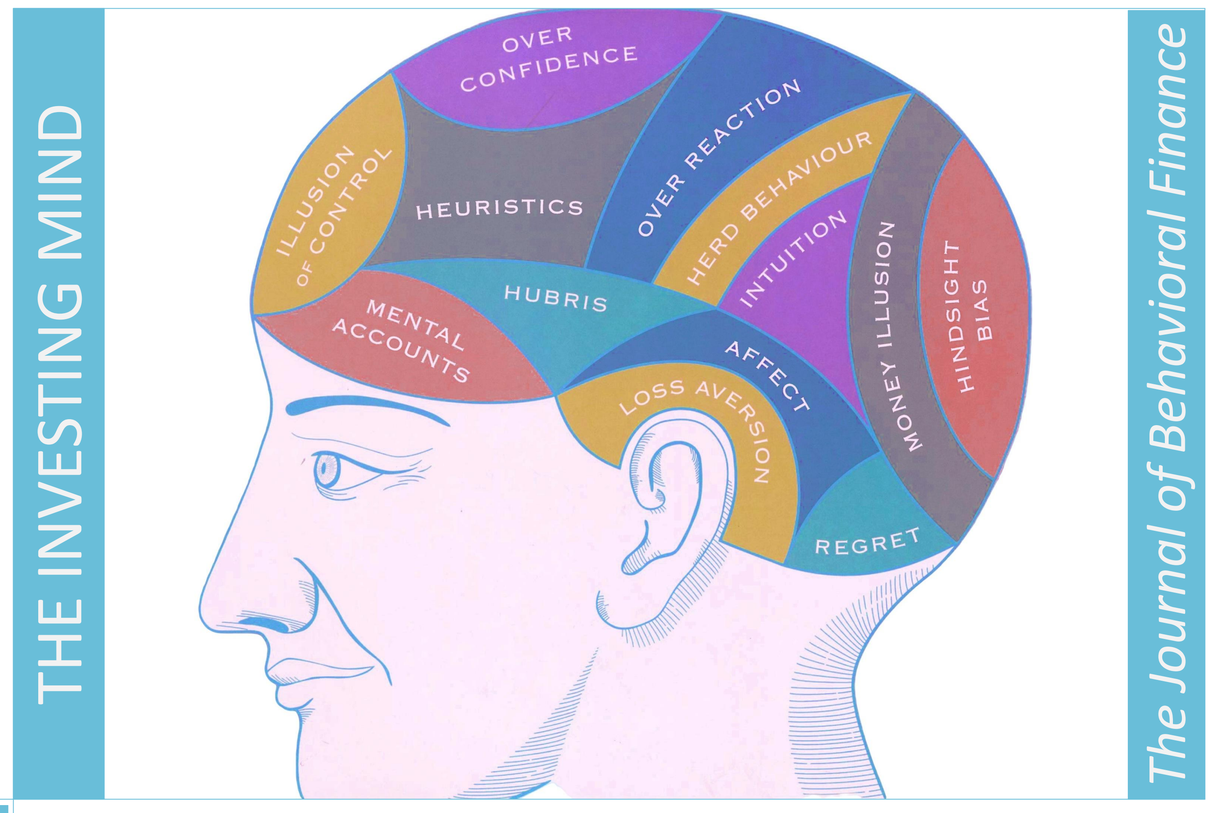
A. Ceschi and R. Sartori, Department of Philosophy, Education and Psychology, University of Verona, Verona.
E. Rubaltelli, Department of Developmental and Socialization Psychology, University of Padova, Padova.
J. Weller, Decision Research, Eugene, USA.

Introduction

The current research is based on studies of different fields, in particular Cognitive Psychology and Economics, a scientific field as known as Behavioral Finance.
Over the years, many studies conduct by psychologists as Daniel Kahneman, Amos Tversky, Paul Slovic and economists such as Benartzi, Thaler, Shefrin, Genesove and Mayer have demonstrated that the heuristics and biases found in the choice processes of individuals, influence the management of the financial assets. Several authors have presented many classifications of biases, which are usually based on theoretical considerations (Arnott, 1998, Baron, 2008; Stanovich & West, 2008; Tversky & Kahneman, 1974). The current research shows an empirical approach in order to study cognitive biases and connections between them, in decision taken in a stock market simulation.
These taxonomies are based on different approaches and rely on different categorization structures. As a consequence, the way they used to assign the category is not homogeneous. The lack of a common criteria and the presence of different categories used to build them do not allow an easy comparison.
Starting from previous taxonomies, we have extracted 49 biases. These biases respect two preconditions: they are easy to reproduce and they investigate a particular psychological construct.
In view with the aim of the research, we have presented these experiments structured in a survey of a sample of 90 subjects, in order to test the degree to which they demonstrate biased reasoning. The subjects were high school students enrolled in a competition called Stock Market Learning, which simulates a real stock market environment.

Aims

With a statistical explorative analysis we intend to study the disposition of the subjects that taken part at this competition to incur in cognitive biases.
We also expect to find several categorizations by studying correlations between biases and analyzing data obtained by using a Multidimensional Scaling and a K-means cluster analysis.



TYPE OF BIAS	DEFINITION
Affection effect	It is an effect due by the influence of negative or positive feeling state in decision making processes.
Anchoring heuristic	It drives people to be depend in judgment and valuations by a reference point.
Aversion to ambiguity	Decision makers dislike ambiguity
Availability heuristic	This disposition drives people to consider more what is more available in their mind.
Base rate fallacy	It is the tendency to ignore base rate in favor of representativeness.
Belief bias	It is a cognitive bias that incur in syllogistic reasoning or more in general in rational processes by inducing people to take a conclusion on the basis of their beliefs.
Confirmation bias	It is an tendency that induce people to prefer information that confirm their hypothesis and to avoid contrary possibilities.
Conjunction fallacy	The conjunction fallacy is a violation of a logical norm and occurs when representative events are consider more probable than how they really are.
Distinction bias	When people make predictions or choices they could be influence by the joint evaluation mode or the single evaluation mode.
Endowment effect	It is the tendency for people to evaluate something that they already own more higher than how really is it.
Forer effect	People tend to accept vague and general personality descriptions as uniquely applicable to themselves without realizing that the same description could be applied to just about anyone
Framing	It is a phenomena that influence people perception in decisions, on the basis of a positive or negative bordered context of decision.
Gambler's fallacy	It is an effect that induce people to consider small sequences of random processes influenced by previous changes.
Hindsight bias	It is a mental process that induce person to see an event already occurred as more predictable than how really it is.
Hyperbolic discounting	Hyperbolic discount functions induce dynamically inconsistent preferences, implying a motive for consumers to constrain their own future choices.
Information bias	This bias is due by an irrational manage of information, in particular when a plus researched information not provides to a better choice.
Illusion of superiority	People tend to rate themselves as better than average.
Imaginability bias	Imaginability of events affects its availability in process of choice.
Opportunity cost	Opportunity cost is the cost of the option not chosen, in general drives people to give an higher value at the choice already chosen.
Optimism bias	It's the tendency to consider a future outcome more probable if it is positive, and less probable if it is negative.
Planning fallacy	Planning fallacy is a sort of illusion that drives people to underestimate the time necessary to complete a task
Prominence effect	Prominence effect compares when of an option present a prominent attribute that influence preferences respect a direct comparison between options.
Pseudo certainty effect	It is an effect seen in choice that induce people to see an outcome more certain than how really is it
Reference price	It is the tendency to assign a price of an object on the basis of the context. It derive by Anchoring heuristic.
Regression toward the mean	It is a phenomena that induce people to do not consider the effect of random in a set of chances.
Regret aversion	Regret is an aversive emotion experienced upon the discovery that, had a different choice been made, a higher level of utility would have obtained than actually did.
Sunk costs fallacy	In economy sunk costs are parts of budget already sustained and often high valued that could compromise future management of budget.
Self-serving bias	A self-serving bias occurs when people attribute their successes to internal or personal factors and attribute their failures to situational factors beyond their control.
The extra-cost effect	It is an effect that drive people to consider a certain sum more important than how it is because already sustained.
Representative bias	It is the disposition to violate the Bayesian calculation of probability in front of a different option more representative.
Wishful thinking	Tendency present in people that drive them to consider an event more probable because more desired.
Zero risk bias	It is a bias that induces people to avoid any form of risk and to strongly prefer option that could eliminate any type of threat.

Participants and Procedure

90 subjects took part in the research (54% females; age range 18 to 20 years). Participants had the minimum mathematical and economical knowledge required to complete the survey. The survey was run online and participants were high school students enrolled in a competition called Stock Market Learning, which simulates a real stock market environment. The competition, driven by savings banks across Europe, gives students the opportunity to invest a virtual capital on the stock market and to learn how financial markets work.

Method

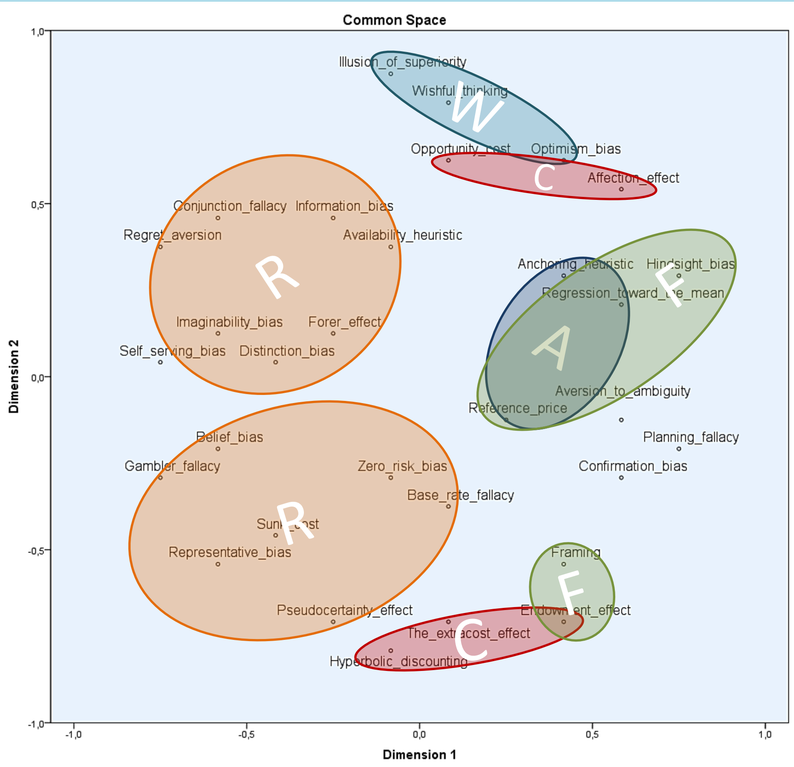
49 items were built ad hoc, starting from previous taxonomies of biases in judgment and decision making, in order to have at least one problem for each bias. We proceeded with an accurate analysis of cognitive errors present in all the most important taxonomies of biases, In particular, the Carter et al. (2007) and Arnott (1998) biases lists were considered. Our work was developed in an empirical way, by considering all biases without any previously formed opinion. This condition is fundamental in order to obtain a list of all of biases present in literature, by obtaining 81 different biases.
The second step consisted in a synthesis and a comparison among all the biases considered. Starting from 81 biases, we have removed all the similar ones, either for description or effect. Another feature of selection procedure was the possibility to test biases empirically. Following this rule, we have discarded all those biases that cannot be directly tested through a survey. According to the empirical aims of the research, we have decided to test only those biases that could be assessed in a standardized instrument, by obtaining 49 biases. For every bias studied, we proceeded by selecting an experiment from the scientific literature and every experiment extracted was transformed into an item.

Data Analysis

At first, data were manipulated in order to detect bias effects. Using a T-test we found an effect only of 31 items as a direct effect of 31 biases, reported in left table. Once that the standardized scores were estimated for all the variables a table containing all the subjects data was produced. According to the aims of research, a multidimensional scaling (MDS) was used to find several relations among biases. We use the Proxscal algorithm[1].

Results

A graphic representation of results was printed (see right picture). The graphic representation based on two dimensions is formed by a Cartesian plane, and determined in an automatic way by the algorithm on the basis of several distances calculated by it. Helped by the taxonomies previously presented, we have individuated several groups of biases. The most significant ones are ring-shaped here presented:
R. Representativeness biases. In decisions these biases are featured by the violation of statistical rules, which are determined by the preference for the options that are more representative.
*W. Wish biases. They a*re characterized by the influence of hope, especially when people desire positive outcomes.
C. Cost biases. They are composed by all the biases that consider costs more valuable than how they really are.
C. Framing biases. They are characterized by the influence of the context in decision making processes.
A. Anchoring biases. These biases are due to the Anchoring heuristic. They respond to a tendency of subjects to be influenced by a reference point.



Credit

Proxscal
Version 1.0
by
Data Theory Scaling System Group (DTSS)
Faculty of Social and Behavioral Sciences
Leiden University, The Netherlands

Case Processing Summary

Cases		31
Sources		1
Objects		31
Proximities	Total Proximities	465[a]
	Missing Proximities	0
	Active Proximities[b]	465

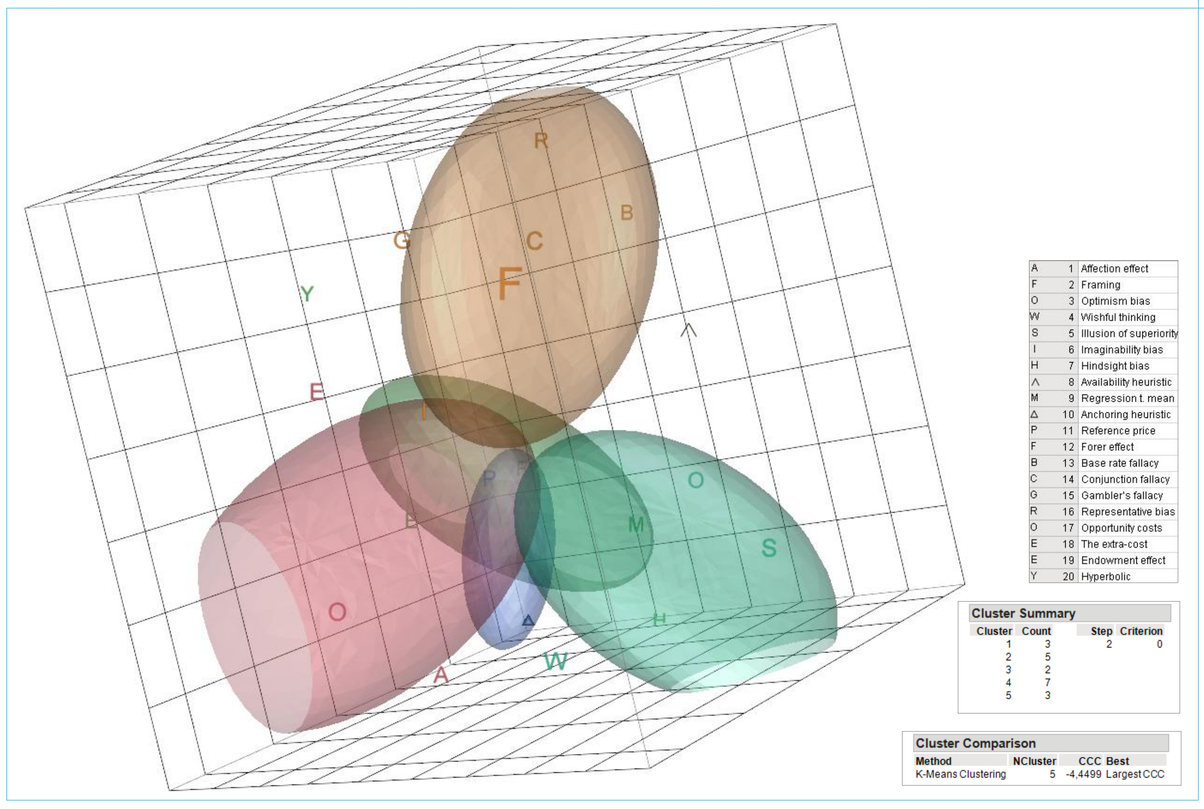
a. Sum of all strictly lower-triangular proximities.
b. Active proximities include all non-missing proximities.

Stress and Fit Measures

Normalized Raw Stress	,13302
Stress-I	,36471[a]
Stress-II	,92568[a]
S-Stress	,29712[b]
Dispersion Accounted For (D.A.F.)	,86698
Tucker's Coefficient of Congruence	,93112

PROXSCAL minimizes Normalized Raw Stress.
a. Optimal scaling factor = 1,153.
b. Optimal scaling factor = ,884.

Considering the groups individuated we studied the Pearson correlations of every group and we focused on the more significant and strong relations.
In order to confirm our hypothesis we run a cluster analyses based on the k-means on the Cosine similarity[2]. We maintained only the 20 biases that showed the most significant correlations in groups. We supposed the presence of five clusters as the MDS analysis had found. In order to see better the clusters found we run the analysis using a 3D model (see the left picture). The clusters found are very similar to groups individuated, especially the Representativeness biases and the Wish biases. Comparing to the first hypothesis The Anchoring biases miss of the Regression toward the mean and the Cost biases miss of two biases. The missing biases were grouped into a unique cluster with the other Framing biases.



A	1	Affection effect
F	2	Framing
O	3	Optimism bias
W	4	Wishful thinking
S	5	Illusion of superiority
I	6	Imaginability bias
H	7	Hindsight bias
Λ	8	Availability heuristic
M	9	Regression t. mean
Δ	10	Anchoring heuristic
P	11	Reference price
F	12	Forer effect
B	13	Base rate fallacy
C	14	Conjunction fallacy
G	15	Gambler's fallacy
R	16	Representative bias
O	17	Opportunity costs
E	18	The extra-cost
E	19	Endowment effect
Y	20	Hyperbolic

Discussion

On the basis of these evidences we can affirm that biases affect people that take decisions in Finance simulation, by working as several constructs here detected. In the next studies, we will consider the idea of relate the biases effects with the performance obtained by the simulation.

Main References

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[1] The algorithm has calculated the Euclidean distances among every bias. In order to present and better study these distances among biases, we preferred to utilize only two dimensions, computed by the algorithm. Considering that in this study only one source is formed by standardized scores, X_z, it is possible to define the present function as follows:

$$\sigma^2 \equiv \sum_{i<j}^{n} w_{ijz}[\hat{d}_{\cdot ijz} - d_{ij}(X_z)]^2$$

Where:
$d_{ij}(X_k)$ are Euclidean distances between the object points, with the coordinates in the rows of X_k.
$\hat{d}_{\cdot ijk}$ are transformation functions for the proximities provides nonnegative, monotonically non-decreasing values for the transformed proximities.
σ^2 is the weighted mean squared error between the transformed proximities and the distances of n objects within m sources.
In step two, the algorithm finds an update for the configurations and, in the next step, it finds an update for the transformed proximities $d_{ij}(X_k)$. In the last step, the algorithm evaluates the loss function, and, if some predefined stop criteria are satisfied, it stops; otherwise, it returns to step two.

[2] The cosine distance might make sense for these data because it would ignore absolute sizes of the measurements, and only consider their relative sizes.