

Behavioral Finance: An Application of Prospect Theory to Brazilian Investors

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Abstract

Behavioral finance has stood out as an interdisciplinary field of study that seeks to understand psychological and behavioral influences on financial decisions. The study aims to investigate the behavior and profile of investors in a financial institution, to understand the associations between their individual characteristics and investment performance. The methodology used was a case study, applying Kahneman and Tversky's theory of perspective. Field study used primary data collected through questionnaires, which allowed to collect direct investor information, while correlation and correspondence analysis provides a better understanding of the relationships between the studied variables. The application of perspective theory has allowed to analyze how investor's perceptions and preferences influence their financial decisions. The results revealed that investors tend to avoid losses and seek financial security, even if it implies renouncing potential gains. Associations were identified between investment performance time, family income level, academic background and value of financial investments. The study allowed an understanding of financial decision-making and insights to raise the quality of customer service by financial institutions.

Keywords: behavioral finance, investment performance, financial decisions

1. Introduction

The Modern Theory of Finance (MTF), in sync with the Efficient Markets Hypothesis (EMH), has as its theoretical basis the studies of Markowitz (1952), Sharpe (1964), Modigliani and Miller (1958, 1963) and Fama (1970). They state that asset prices already incorporate all the information available in the market when investors evaluate their decisions rationally and have an aversion to risk in their decision-making process. However, these theories are unable to explain certain deviations that affect decision-makers.

The gap left by MTF and EMH theories allowed the emergence of a line of thought in finance known as Behavioral Finance. This approach is based on the Prospect Theory (PT) proposed by Kahneman and Tversky (1979), which questions the EMH on the assumption that economic agents do not have unlimited rationality and are averse to losses in their decision-making process.

The aim of this study was to research and evaluate the behavioral effects of investors that interfere with the investment decision-making process. A correlation analysis with previous studies and a correspondence analysis were carried out in order to identify relationships between quantitative and categorical variables, respectively. These techniques allow identifying patterns and trends in the responses, making it easier to interpret the data. The methodology used was a quantitative approach, using questionnaires and the application of Kahneman and Tversky's Perspective Theory with a field study.

The study was justified by the fact that Behavioral Finance has become increasingly relevant worldwide for understanding the decision-making of economic agents. This is because this approach seeks to fill a gap left by Modern Finance Theory and the Efficient Markets Hypothesis (Fama, 1970; Markowitz, 1952), which presupposes rational, maximizing behavior on the part of the investor. The behavioral approach, in turn, considers non-rational factors that can influence decision-making, such as emotions, cognitive biases and heuristics (Tversky & Kahneman, 1974).

According to the research carried out by Camara and Santos (2017), this interest has intensified in recent years,

with the publication of several articles in national and international journals on the subject. In the Brazilian financial market, Behavioral Finance has become increasingly relevant. This is because the Brazilian Association of Financial and Capital Market Entities (Anbima) has included the topic in its investment specialist certifications, making it mandatory for candidates to pass the exam (Anbima, 2021).

This highlights the importance of knowledge of Behavioral Finance for the performance of activities in the financial market. The aim of this study is to contribute to the constant growth of the field of Behavioral Finance by presenting results that can add to the knowledge already produced on the subject. In such manner, we seek to improve our understanding of the decision-making process of economic agents corresponding to the allocation of their resources, taking into consideration maximizing the return on their investments.

2. Literature Review

This section presents the theoretical bases on which this study is established.

2.1 Behavioral Finance

The evolution of the financial decision-making process has included Daniel Bernoulli's Expected Utility Theory and Harry Markowitz's Modern Portfolio Theory (MPT), which is based on the investor's unlimited rationality. However, these theories fail to standardize the decision-making process as they do not take into account emotional aspects, information asymmetry and the investor's limited rationality (Anache & Laurencel, 2013).

The Prospect Theory, created by psychologists Daniel Kahneman and Amos Tversky in the late 1970s, gave rise to the new field of finance known as Behavioral Finance. This field seeks to refute the concepts of MPT, which is based on the premise that economic agents decide through unlimited rationality, have an aversion to risk and aim to maximize the expected utility in each decision (Yoshinaga & Ramalho, 2014).

2.2 Sampling Procedures

Prospect Theory (PT), proposed by Kahneman and Tversky (1979), emerged as an alternative to Expected Utility Theory (EUT), which was axiomatized by Von Neumann and Morgenstern (1944). The authors noted that the model suggested by Bernoulli (1738), and axiomatized by Von Neumann and Morgenstern (1944), could not fully describe the decision-making of individuals in certain situations. They argued that the decisions made by investors in risky situations were not consistent with the basic principles of modern finance theory (Kimberley, 1996).

The Expected Utility Theory is based on expected wealth and the final probabilities of assets for decision-making in risky situations. In contrast, PT uses reference values and decision weights to make decisions. These characteristics were pointed out as supplying what the EUT could not explain about human behavior (Kimberley, 1996). According to Kahneman and Tversky (1979), Prospect Theory was developed for deciding on the best prospects (the best choices), with economic/monetary results and stated probabilities, but it could also be used for more choices involved in this process.

The basic variables considered in Prospect Theory are: value function, decision weights and effects, as detailed in the following topics.

2.2.1 Value function

Prospect Theory, developed by Kahneman and Tversky (1979), has as one of its main characteristics the consideration of changes in the decision maker's wealth or well-being, in contrast to Expected Utility Theory, which is based on final states. This assumption is in line with the basic principles of perception and judgment, since the human perceptual apparatus is synchronized with the evaluation of changes or differences, and not with the evaluation of absolute quantities.

These authors use examples such as the perception of brightness, temperature, or volume to illustrate the importance of the reference point in decision-making. The past and present context of the experience lived by the decision-maker will point to a reference point, and the attributes will be perceived in relation to this point (Tversky & Kahneman, 1992).

The emphasis on changes as a value carrier should not be interpreted as if the value of a particular change is independent of the reference point. Briefly, the value should be reported as a function on two arguments:

- The asset position serves as the reference point; and
- Magnitude of change (positive or negative) from the reference point.

According to Tversky and Kahneman (1992), an investor's attitude towards their capital can be described as a dictionary, where each section presents the value function in a specific position of the reference point. The value functions described in each section are not identical and tend to become more linear as the number of sections

increases. However, the order of investor preference is not significantly altered by small or medium variations in the position in each section.

2.2.2 Decision Weights

According to Kahneman and Tversky (1979), in Prospect Theory, decision weights can lead to risk aversion or risk seeking, even with a linear value function. Decision weights are defined based on choices between the best alternatives (prospects), which are subjective. It is important to note that weights are not probability variables, as they do not obey the axioms proposed by the theory and should not be interpreted as a degree of value (Köberling & Wakker, 2001).

Figure 1 graph illustrates the hypothetical weight function proposed by Kahneman and Tversky (1979):

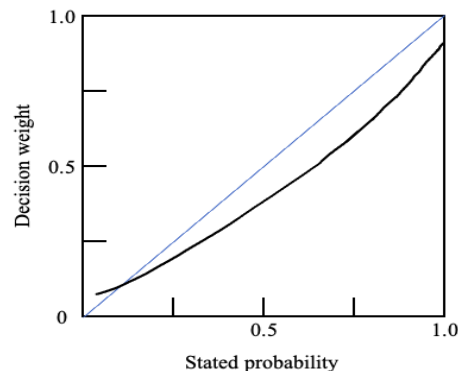


Figure 1. Value of the hypothetical weight function

Source: Kahneman e Tversky (1979).

The hypothetical weight function, proposed by Kahneman and Tversky, is a theoretical approach that describes how people evaluate and make decisions in situations of uncertainty. This function suggests that people assign different weights to identical probabilities, influenced by factors such as the way information is presented and risk aversion. This theory allows us to better understand how people evaluate and make decisions in contexts of uncertainty, providing insights into the psychology behind the decision-making process (Kahneman & Tversky, 1979).

2.2.3 Effects

As pointed out by Kimberley (1996), the authors concluded that choices in situations of risk present various aspects that are inconsistent with the fundamental principles of the Expected Utility Theory of Von Neumann and Morgenstern (1944). The effects identified by the authors are listed below:

- **Certainty effect:** Individuals underestimate probable outcomes compared to those that are certain. This effect brings risk aversion to choices involving certain levels of gain and risk seeking to choices involving loss (Yoshinaga, 2014).
- **Isolation effect:** For Kahneman and Tversky (1984), the isolation effect is one of the effects identified by the authors in Prospect Theory. This effect occurs when individuals face a choice between different scenarios and disregard components that are common to all possible alternatives under consideration. This effect can generate another phenomenon called “Framing”, which means that different ways of expressing the same situation can lead to different results (Kahneman & Tversky, 1984).
- **Reflection effect:** Would be an equivalence of the choices involved, both negative and positive. In other words, the alternatives, being positive for example, are a mirror image of the negative choices (Yoshinaga, 2014).
- **Possession effect:** “When it is more painful to give up a good than it is pleasurable to obtain it, purchase prices will be significantly lower than sales prices” (Kahneman & Tversky, 1984, p. 348).
- **Formulation or framing effect:** Based on the results of the isolation effect, also considering that the value function has a non-linearity in PT, and the fact that decisions are made based on the reference point. This effect arises when the choices for the same problem can be different according to the way in which it is formulated or framed (effect named as framing effect) (Kahneman & Tversky, 1984).

Next, the methodology and results of the field research will be discussed.

3. Method

A case study was carried out at a financial institution with the aim of investigating the behavior and profile of investors in order to understand the associations between their individual characteristics and investment performance. In methodological terms, the typology of the research and the procedures for analyzing the data will be presented.

3.1 Research Typology

The research design, which considers the classification in terms of purpose, can fall into three categories: exploratory, descriptive or explanatory (Saccol et al., 2012). The typology of this study was classified as exploratory-descriptive.

Descriptive research, as defined by Gil (2010), seeks to describe, characterize and map information on the subject determined in the research. The exploratory approach (Gil, 2008) aims to provide a panoramic and general view of the subject, trying to achieve a familiarity that has been little explored in recent years, in order to build hypotheses and make the study more explicit.

As for the research paradigm, which is the philosophical basis that will guide the chosen method, this study was framed within the quantitative (positivist) paradigm, as defined by Crotty (1998). The choice of the quantitative approach is due to the use of methods that involve the use of statistical instruments to collect and analyze data, in order to quantify the results obtained and establish associations between them (Richardson, 2007).

This study was classified as field research, with the aim of seeking information about a specific problem for which an answer is sought (Marconi & Lakatos, 2003). This classification is due to the fact that field research is a methodological approach that aims to collect data and information directly where the phenomena being studied occur. The indicated approach allowed us to obtain relevant insights into the behavior of the participating investors in order to identify possible associations with the behavioral biases mentioned above.

As for the choice of systematic procedures to describe and explain phenomena, it was used the survey method through questionnaires to identify the behavior of a financial institution's investors in the decision-making process (Malhotra, 2012). Through this survey method, it was possible to obtain information in a standardized and systematic way, ensuring that all questions were asked consistently to all participants. This facilitates comparison and analysis of the data collected, allowing patterns and trends to be identified.

As for the database, primary data was used, which is information collected directly by the researcher (Saccol et al., 2012). This "raw" data was obtained through questionnaires filled in by investors, with the aim of mapping the phenomenon of decision-making by economic agents.

As for the nature of the research, it was classified as applied, since it was aimed at applying the questionnaire drawn up by Kahneman and Tversky, focusing on mapping the decision-making process of investors in a given financial institution (Gil, 2008). It should be noted that this questionnaire was updated by the author, Caio F. Torralvo (2010), in order to make it more suitable for the context of this research.

3.2 Data Analysis Procedures

After collecting data through questionnaires, the data were analyzed. For this analysis, correlation, and correspondence analysis techniques were used, which are suitable for identifying relationships between quantitative and categorical variables, respectively. These techniques make it possible to identify patterns and trends in the responses, making it easier to interpret the data.

4. Analysis and Discussion of the Results

The field research was carried out in May 2023 using electronic questionnaires sent to investors of a financial institution. 41 responses were obtained, revealing information about the profile of the respondents and their investment preferences.

4.1 Profile of Respondents

The data showed a balanced gender distribution, with 51.2% women and 48.8% men. The majority of investors (58.5%) have financial dependents. As for owning a property, 63.4% own their own home. In terms of academic background, the most common area is Business Administration (22% of the sample). As for professional occupation, 29.3% are salaried professionals.

A monthly family income of over R\$ 10,000.00 is the most common among the respondents (73.2%). The majority (68.3%) have no experience of managing financial resources. As for the value of their financial investments,

34.1% have more than R\$ 100,000.00. The majority evaluate the performance of their investments for less than a year (41.5%). Finally, the majority of investors (80.5%) classify the results of their investments in recent years as positive.

4.2 Identification of Behavioral Biases

The field research aimed to collect data from 16 behavioral questions on Prospect Theory, more precisely on the behavioral biases Certainty Effect, Reflection, Isolation and Probabilistic Insurance, being the second stage of data collection in this study. The data were obtained through a systematic survey using a behavioral questionnaire, in which participants were asked about their preferences and choices in hypothetical situations. The analysis of this data provided information on the behaviors and trends observed in the sample studied. Participants were presented with different scenarios and asked to choose between two alternatives (A and B) and one question (13) addressing their preference for hypothetical insurance (YES or NO). The answers were registered and categorized for later analysis.

The following topics present the results of the survey and the respective analyses.

4.2.1 Certainty Effect Bias

The study analyzed how the certainty effect influences the choices of research participants. The results showed that economic agents tend to overestimate certain outcomes, even when they are less profitable than less certain outcomes. Pairs of questions were compared, and it was observed that participants chose prospect B in question 1, which offers a certain gain of R\$ 2,400.00. Prospect A in question 2, offers a chance of gaining R\$ 2,500.00, but also a chance of gaining nothing. This indicates that agents value certainty and prefer the highest value when there is a chance of winning.

In addition, agents tend to risk more when the chances of winning are very low or almost zero. These results corroborate with previous studies and shows that the certainty effect is a cognitive bias that influences economic decisions. These findings have important implications for both individual and collective economic decision-making.

4.2.2 Reflection Effect Bias

In analyzing the results of the reflection effect, it was investigated how weighting was manifested in the choices made by the investors taking part in the research. When comparing problems 3 and 9, it has been noted that investors tend to prefer a guaranteed gain to a chance of gain, but choose the more uncertain option when it comes to losses. This indicates an aversion to risk and the reflection effect, reversing the order of preference. However, it was not found statistical evidence of the influence of the reflection effect in the other pairs of questions, except for the pair 7-11, which also showed similar results to previous researches. This suggests a possible association with the influence of the reflection effect on the research participants' decision-making process.

4.2.3 Probabilistic Insurance

The section on probabilistic insurance explores the participants' reaction to this proposal. The results indicate that the majority of participants were not interested in insurance, which is in line with previous research. Surprisingly, participants valued the reduction of the risk of loss less than the complete elimination of that risk, contradicting the idea that people prefer to avoid any risk, even if it means a smaller reduction in potential gains. This suggests that participants may have a more complex approach to risk assessment and decision-making.

4.2.4 Isolation Effect Bias

The study investigated the isolation effect on participants choices. The results showed that participants tend to focus on only part of the information presented, ignoring other relevant information. When comparing questions 4 and 14, it was observed that the majority of participants chose the option with a certain gain in both situations, even when the alternative option involved a chance of loss. This highlights the influence of behavioral biases on decision-making and underscores the importance of considering these effects when formulating financial strategies. Understanding these biases can lead to more informed and effective decision-making.

4.3 Correlation with Previous Studies

This session involved analyzing the correlation between the current study and previous researches. The proportions of participants deciding between options A and B in each question in the current study were examined, as well as in previous research by Kahneman and Tversky (1979) and Torralvo (2010). The linear correlation was calculated to determine the similarity between the proportions of A and B in the three surveys. The results showed a strong positive correlation between the current study and previous research, with both Torralvo (2010), having a correlation of 0.94, and Kahneman and Tversky (1979), containing a correlation of 0.93, indicating a consistent

trend between the studies' data. The correlation between the original study by Kahneman and Tversky (1979) and the previous study by Torralvo (2010) was 0.91.

4.4 Correspondence Analysis

Based on the quantification carried out on these 16 questions, the proportions were correlated with previous studies to identify similarities. Due to the existence of other qualitative variables, correspondence analysis was carried out to create a scenario of association between characteristics. A focus was on expanding the study in the future, based on the triggers found in this exploratory data technique.

Figure 2 graph presents the correspondence map showing the relationship between investments performance time and family income level. It was observed that individuals with a family income above R\$ 10,000.00 did not show a strong association with any of the investment time categories. Within the same investment time categories, opposite groups were identified with relevant associations. For example, investors with less than a year's experience, who have a family income of 2.5 to 5 thousand reais, and those with 1 to 2 years experience, who have a family income of 5 to 10 thousand reais.

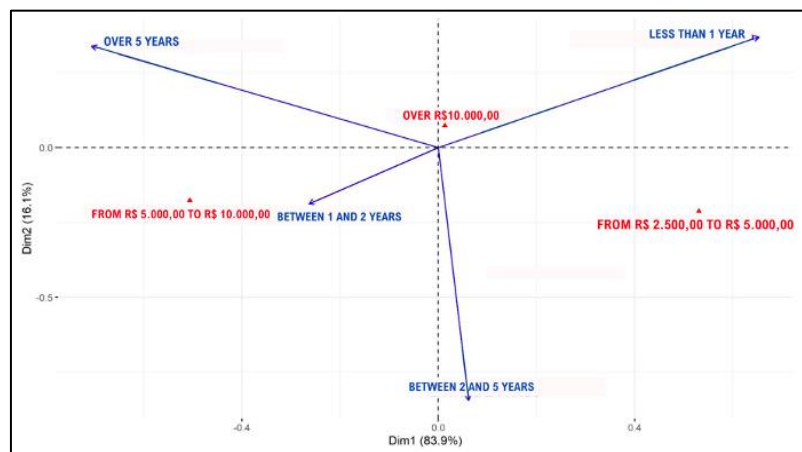


Figure 2. Correspondence map between investment performance time and family income level

Based on Figure 3 graph, which shows the association between higher education and the level of family income, it is possible to see some patterns. Law, Business Administration, Engineering and Economics degrees are more associated with lower levels of family income. However, at the intermediate level of family income, there are no significant associations with any education. Nevertheless, at higher family incomes, such as R\$ 10,000.00 per month, degrees in Administration, Law and other areas show a strong association.

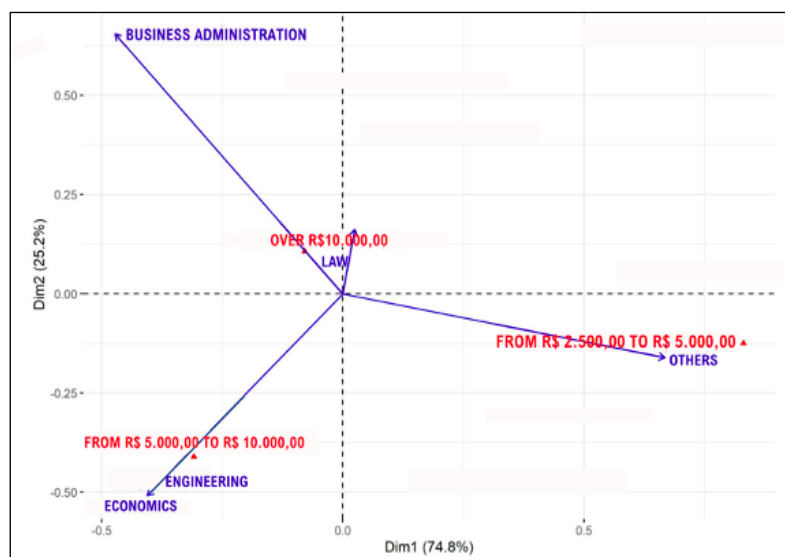


Figure 3. Correspondence map between higher education and family income level

Figure 4 graph, which shows the association between higher education and investment performance time, provides some relevant information. There is an opposition between Economics and Law degrees, the first being more associated with an investment performance time of between 1 and 2 years, while the second is more associated with a performance time of less than 1 year. An Engineering degree is more associated with an investment performance time of more than 5 years, while an Administration degree is less strongly associated with a performance time of between 1 and 2 years.

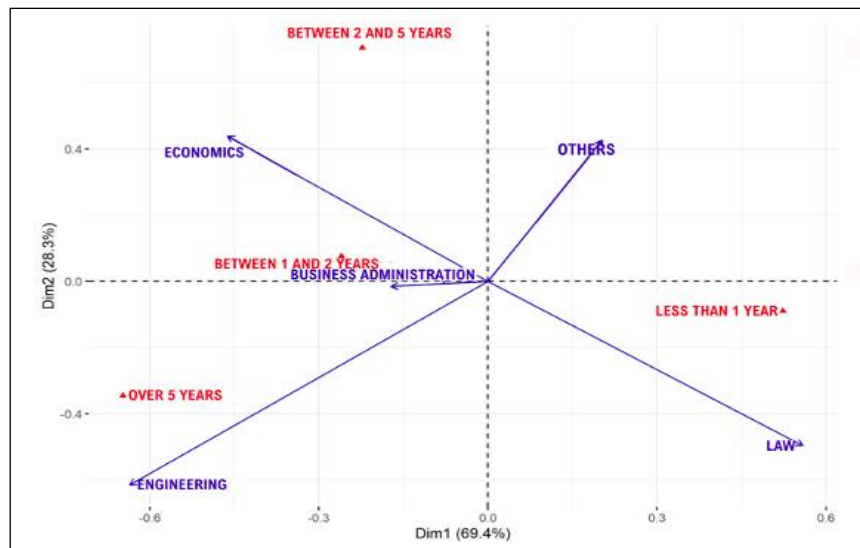


Figure 4. Correspondence map relating to higher education and investment performance time

Figure 5 graph shows significant associations between investment performance time and the value of financial applications. Investments of a lower value are associated with a shorter investment time, while investors with more than R\$ 100,000.00 invested have an investment time of less than 1 year. Investors with a longer investment time, such as more than 5 years, have a strong association with accumulated capital of between R\$ 10,000.00 and R\$ 20,000.00. This trend is also observed for investors with 1 to 2 years and 2 to 5 years of experience, associated with values between R\$ 50,000.00 and R\$ 100,000.00 and between R\$ 5,000.00 and R\$ 10,000.00, respectively.

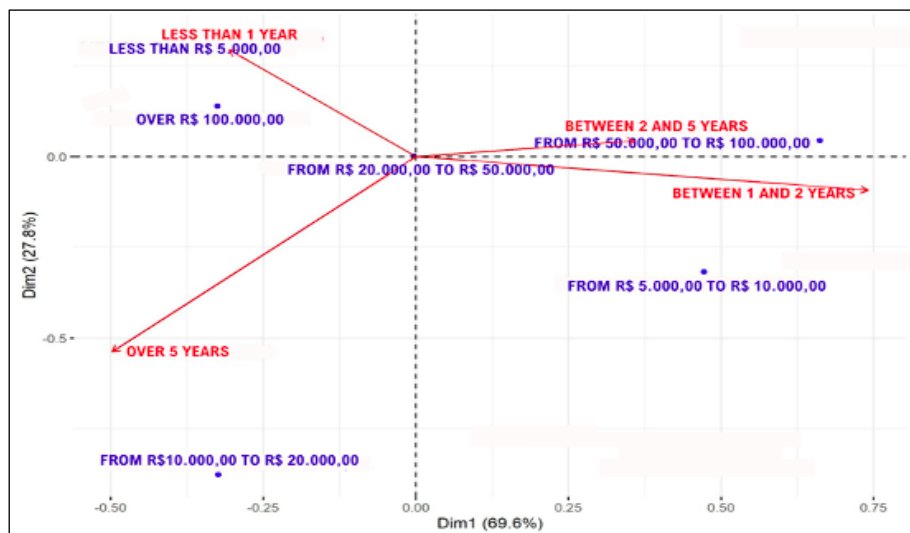


Figure 5. Correspondence map - Investment performance time and value of financial applications

Figure 6 graph reveals strong associations between the value of financial investments and the level of family income. Those with less than R\$ 5,000.00 in financial investments have a low family income, while those with a family income of R\$ 5,000.00 to R\$ 10,000.00 have significant associations with financial applications of

R\$ 20,000.00 to R\$ 50,000.00. Those with the highest level of family income, above R\$ 10,000.00 per month, have more varied associations, including financial investments above R\$ 100,000.00. These observations suggest a relationship between family income and the value of financial investments.

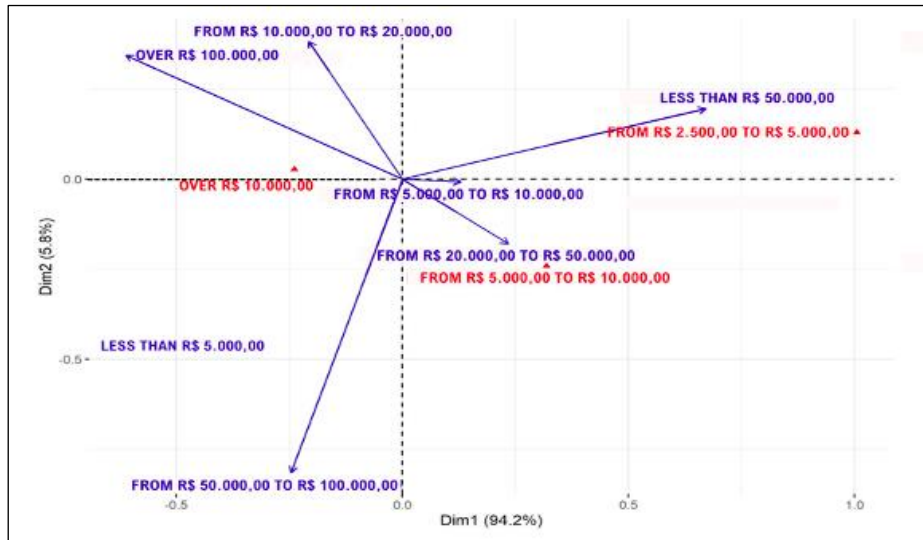


Figure 6. Correspondence map between the value of financial investments and the level of family income

Figure 7 graph displays interesting associations between higher education and the value of financial investments. Clients with a degree in Business Administration are associated with an investment portfolio ranging from R\$ 10,000.00 to R\$ 50,000.00. Engineering graduates are not concentrated in any specific investment class, showing diversification. Economics graduates have a strong association with investments in the R\$ 50,000.00 to R\$ 100,000.00 range. The Law degree, on the other hand, shows a great variability in the level of investment, ranging from investors with less than R\$ 5,000.00 to investors with more than R\$ 100,000.00. These observations reveal the relationship between higher education and the value of financial applications, highlighting the specific characteristics of each area of study.

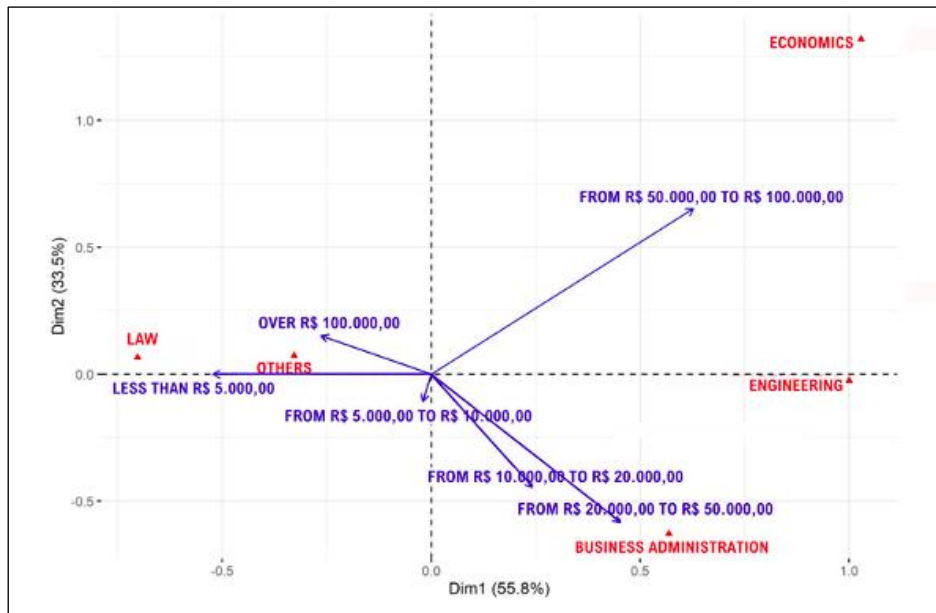


Figure 7. Correspondence chart - Higher education and value of financial investments

The correspondence analysis revealed associations between investment performance time, family income, higher education and the value of financial investments. Investors with incomes above R\$ 10,000.00 did not reveal strong associations with specific investment time categories. However, groups with relevant associations were identified,

such as investors with less than a year's experience and a family income of 2,5 to 5 thousand reais, and those with 1 to 2 years experiences and a family income of 5 to 10 thousand reais.

In addition, degrees in Law, Business Administration, Engineering and Economics showed different associations with levels of family income and amounts of financial investments. For example, degrees in Business Administration and Law were associated with higher family incomes and higher values of financial investments. In conclusion, this analysis provides an in-depth understanding of the relationships between these variables, offering valuable insights for financial decision-making and highlighting the influence of family income and higher education on individuals' investment strategies.

5. Final Considerations

The study concluded that behavioral biases play a significant role in investment decision-making. The participants tend to make less optimal decisions due to risk aversions, preferences for guaranteed gains and risk propensities in relation to losses.

Correlation analysis revealed a significant consistency between the frequencies observed in the current study and in previous studies, strengthening the validity of the results. The correspondence analysis made it possible to identify relevant patterns and associations between the variables of interest, such as academic background, level of family income and value of financial investments.

However, it is important to note that the study is based on a limited sample of clients of financial institution X, and may not be generalizable to the population at large. Future studies may choose to include a more diverse sample of investors in order to obtain more representative results.

In addition, further studies could focus on investigating the effects of different investment strategies tailored to each client profile, comparing their performance with more generic or standardized strategies. This could be useful to further refine the offer of financial products and services to customers and improve financial results and user experience.

The results obtained highlight the importance of considering behavioral aspects when making investment decisions. This information can be used to develop personalized investment strategies and improve the offer of financial products and services to customers.

Author Contributions

The authors also contributed to the study and both read and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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