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ORIGINAL ARTICLE

How do young low-income university students deal with risk and time preferences in Brazil?*,**

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ABSTRACT

This article sought to understand the behavior of young low-income university students through an experiment based on prospect and hyperbolic discounting theory, with risk and time preferences, and their relationships with financial literacy with regard to choice probability distortions. There is a notable lack of studies that simultaneously address risk and time preferences in low-income urban groups, relating experiments based on prospect theory to capture probability distortions in choice processes. This study opens the doors for the question of the relationship between poverty and risk and time preferences to be better discussed in Brazil with the aim of providing evidence that supports national financial literacy plans. The study shows the importance of financial education as a means of reducing agents' probability distortion. This is crucial, given that probability distortion is one of the pillars of prospect theory. This experiment was based on prospect and hyperbolic discounting theory and used value, weight, and quasi-hyperbolic discounting functions within a maximum likelihood methodology to estimate the risk and time parameters with sociodemographic variables, and with the Financial Literacy Index moderating variable, in a private HEI, with 54 students and 5,940 lotteries. It was observed that low-income urban populations in emerging economies have similar risk and loss aversion parameters to rural populations in developing countries. Low-income students have a greater preference for the present, with it being perceived that a small increase in income is associated with a higher level of patience, making decisions more rational. A better financial education could lead to a smaller probability distortion.

Keywords: behavioral finance, prospect theory, quasi-hyperbolic discounting, financial literacy, low-income university students.

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1. INTRODUCTION

Analyzing risk aversion and time preference is important for understanding and explaining individuals' decisions at different moments in their lives (Ferecatu & Önçüler, 2016). Most of the studies either analyze risk preferences (l'Haridon & Vieider, 2019) and time preferences separately (Wang et al., 2016), or when they analyze them together, they focus on rural areas, especially in sub-Saharan Africa or Asia (Tanaka et al., 2010; Nguyen, 2011; Liu, 2012; Liebenehm & Waibel, 2014; Tanaka & Munro, 2014; Ruhinduka et al., 2020). When limiting these studies to Brazil or to Latin America, little research is found, and this only focuses on the area of risk aversion (Cárdenas & Carpenter, 2013; Cárdenas et al., 2014; Bogliacino & González-Gallo, 2015; Lobel et al., 2017).

A much discussed question in the area of developmental economics is to what extent economic success is related to basic characteristics of individuals' preferences (Falk et al., 2018). If individuals are extremely risk averse, they may be reluctant to acquire insurance and make investments, especially if these are associated with uncertain cash flows. On the other hand, if people are impatient, they may not only be reluctant to open new businesses but also to educate their own children. One existing hypothesis in the literature is that, if analyzed together, both preferences partly explain why poverty persists in certain regions (Yesuf & Bluffstone, 2009, 2018; Tanaka et al., 2010; Wang et al., 2016).

Within that context, this study aims to identify the risk behavior and time preference of a group of low-income university students, as well as observing the relationship between both age and income and the estimators. In addition, the inclusion of a financial education moderating variable aims to verify how the risk and time estimators interact with that variable. By associating the previously described lack of studies on risk and time preferences in Latin America with the lack of studies on the same preferences in low-income people in urban areas – exceptions are those of Cardenas and Carpenter (2013) and Cook et al. (2013) – this paper, regardless of being a pilot, aims to close a notable gap in this research area and contribute to the field of behavioral finance that has been developing in Brazil (Silva et al., 2019).

This paper is divided as follows: the second section covers the theoretical framework, prospect theory, and the quasi-hyperbolic discounting model, which serve as a basis for our research; the third presents the methodology; the fourth presents the results; and the fifth section concludes the study with the concluding remarks and suggestions for future research.

2. THEORETICAL FRAMEWORK

2.1 Prospect Theory and Hyperbolic Discounting

Despite the rational decision-making models, such as the expected utility theory from Von Neumann and Morgenstern (1944), still being the basic premise for economic agents in the area of economics and finance, in recent decades, experimental and field evidence has suggested that these rational theories are not adequate descriptions of individuals' actual preferences (Rieger et al., 2017).

The non-expected utility theories emerged as a solution to this inconsistency between individuals' expected and actual behavior (Starmer, 2000). Among the most important theories that try to empirically explain that incongruence between the prediction of individuals' behavior based on expected utility theory and the behavior actually observed are prospect theory, developed by Kahneman and Tversky (1979), and its more refined version, cumulative prospect theory, elaborated by Tversky and Kahneman (1992).

In relation to the discount rate, it is common to assume an exponential discount rate in economic and financial studies, whose percentage is constant and proportional to the waiting time, represented by an exponential curve. However, human beings use a subjective discount rate, the most widely employed of which is the quasi-hyperbolic discount rate (Laibson, 1997; O'Donoghue & Rabin, 1999; Benhabib et al., 2010). In that discounting model, the discount rate is greater for events occurring in closer periods than for occurrences at further moments in time from the current period.

In this paper, we assume that low-income individuals behave according to the cumulative prospect theory of Tversky and Kahneman (1992). Based on that, each individual's utility is defined in equation 1.

$$PT(x,y,p;1-p)\begin{cases} v(\mathrm{y}) + \mathrm{w(p)}\big(\mathrm{v(x)} - v(\mathrm{y})\big), \text{if x} > \mathrm{y} > 0 \text{ or x} < \mathrm{y} < 0 \\ \mathrm{w(p)}v(\mathrm{x}) + \mathrm{w}(1 - \mathrm{p})v(\mathrm{y}), \text{if x} < 0 < \mathrm{y} \end{cases} \quad (1)$$

in which *PT (x, y, p; 1 − p)* is the function that models a binary choice process between payoffs (*x, y*), whose probabilities of occurrence are (*p; 1 − p*).

As a basis for the value function, which is equivalent to the utility function in prospect theory, we will adopt the functional form defined in equation 2, based on Kahneman and Tversky (1979).

$$V(x)=\begin{cases} x^{\alpha}, \text{ if } x\geq 0 \\ -\lambda(-x)^{\beta}, \text{if } x<0 \end{cases} \quad (2)$$

That function is divided into two parts, where the concave part represents the gains and the convex part represents the losses, with the decision maker having risk aversion in the gains part and a preference for risk in the losses part, in which α and β measure the curvature of the value function for gains and losses, respectively, and λ is the coefficient of loss aversion. The value function can be represented by Figure 1.

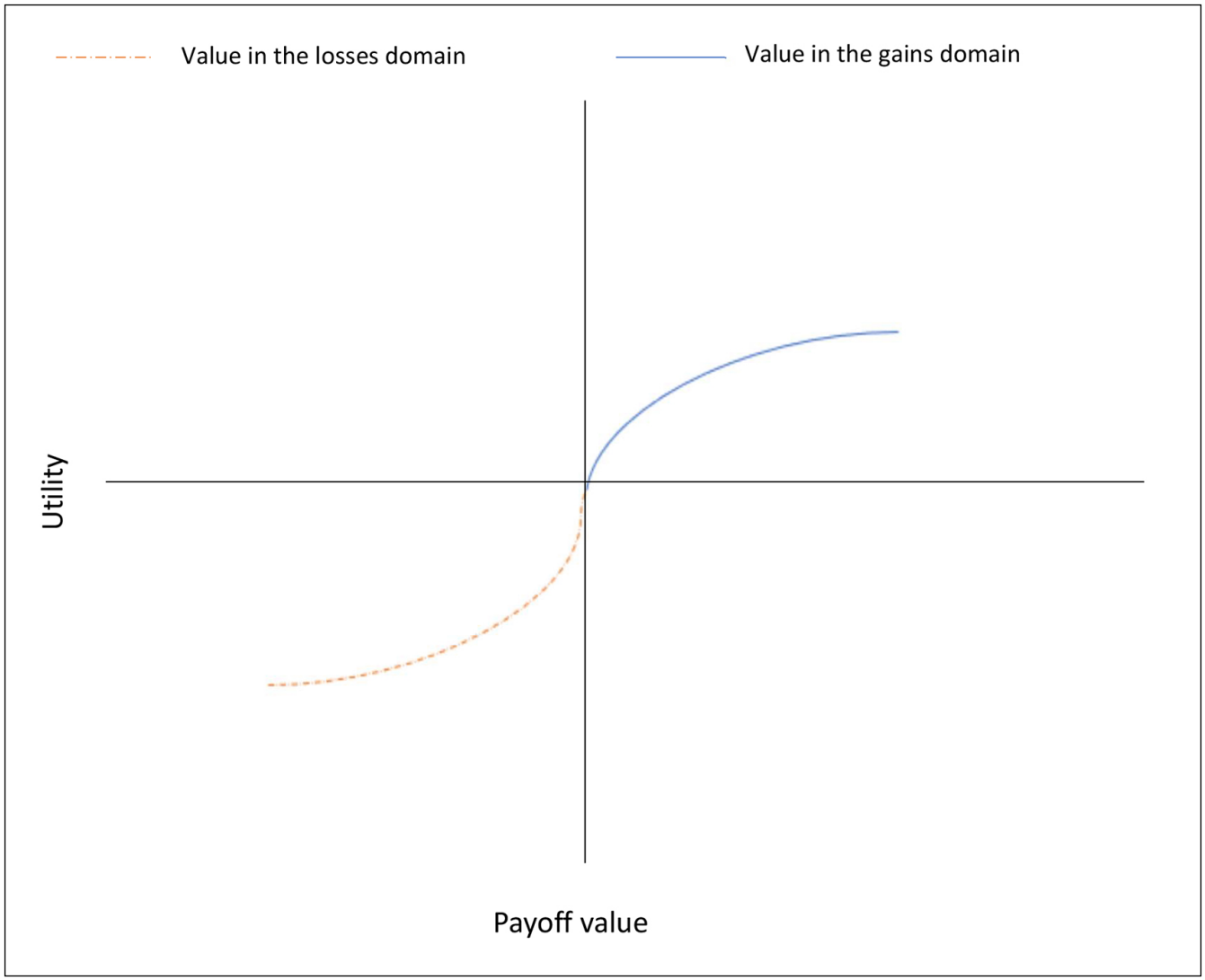

Figure 1 *Value function according to prospect theory*
Source: *Kahneman and Tversky (1979).*

In line with the premises of prospect theory, we will assume that agents distort the probability according to a weight function, defined as π: [0,1] → [0,1], which transforms the objective probabilities, observing the restrictions π (0) = 0 and π (1) = 1. This weight function therefore takes into account the fact that people do not use objective probabilities (*p*) at the time of taking decisions, but rather subjective probabilities π(i).

There are various functional forms for the weight function, a commonly used one being that of Tversky and Kahneman (1992). In this paper, we used the weight function developed by Prelec (1998), defined in equation 3.

$$W(p) = e^{-(-\ln p))^{\alpha}} \quad \boxed{3}$$

in which α represents a proxy for the distortion of objective probabilities *p*.

Figure 2 compares Prelec's (1998) weight function with that of Tversky and Kahneman (1992).

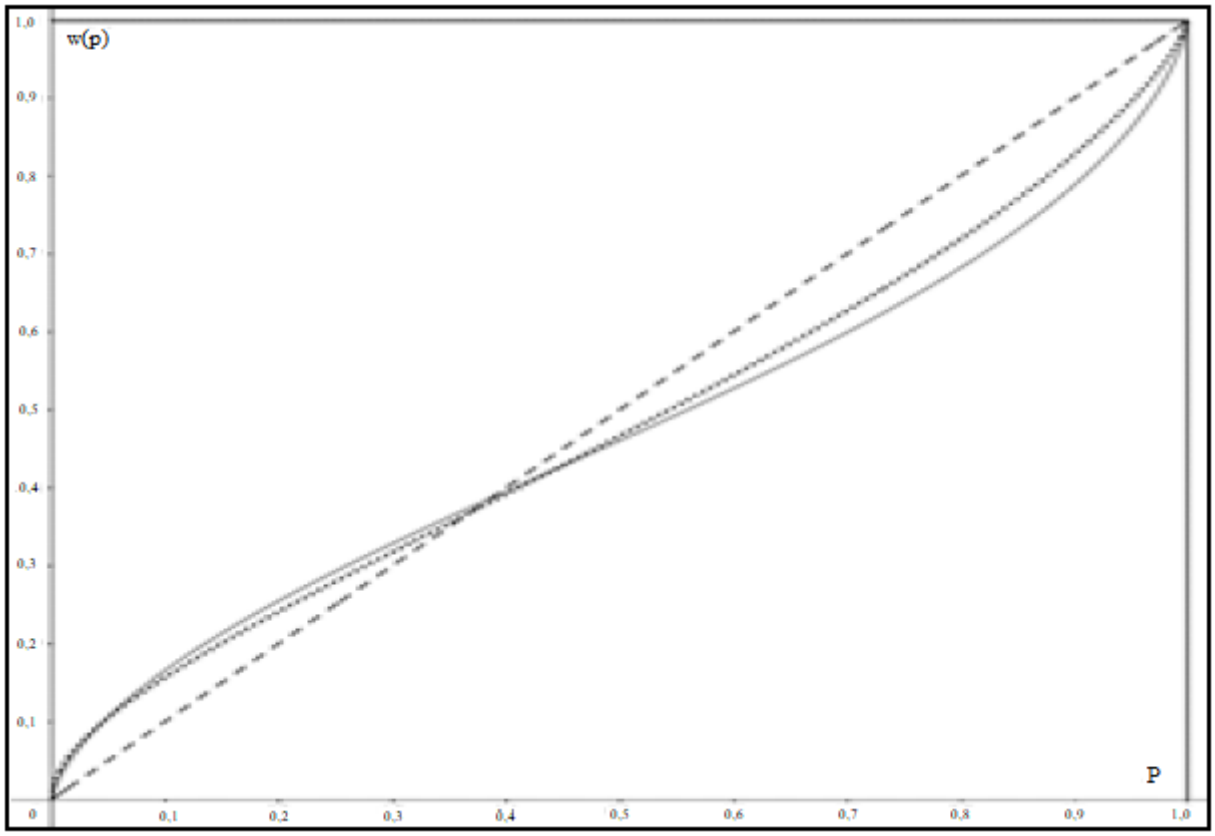

Figure 2 *Weight functions*
Note: *The curves represent comparisons of the functions of Tversky and Kahneman (1992) (solid line) and Prelec (1998) (dotted line) in relation to the straight line of objective probabilities (dashed line).*
Source: *Elaborated by the authors.*

In relation to the objective probabilities, both distorted probability functions exaggerate the small ones and underestimate the moderate and large ones. That characteristic is called the "regressive effect." In particular, the characteristic of overvaluing small probabilities, both for gains and for losses, explains people's demand for lotteries and insurance.

The choice of Prelec's (1998) functional form has fundamental importance, as the author obtains, in a mathematically rigorous way, the probability functions based on an axiomatic approach that reveals the decision makers' actual behavior and is anchored in the common ratio effect (Allais, 1953).

In this sense, it warrants highlighting the study of Benhabib et al. (2010), which reinforces the idea that preference reversion is not consistent with exponential discounting, but rather with a decreasing discount rate over time. Thus, various discounting specifications have been suggested, notably hyperbolic and quasi-hyperbolic discounting (Figure 3).

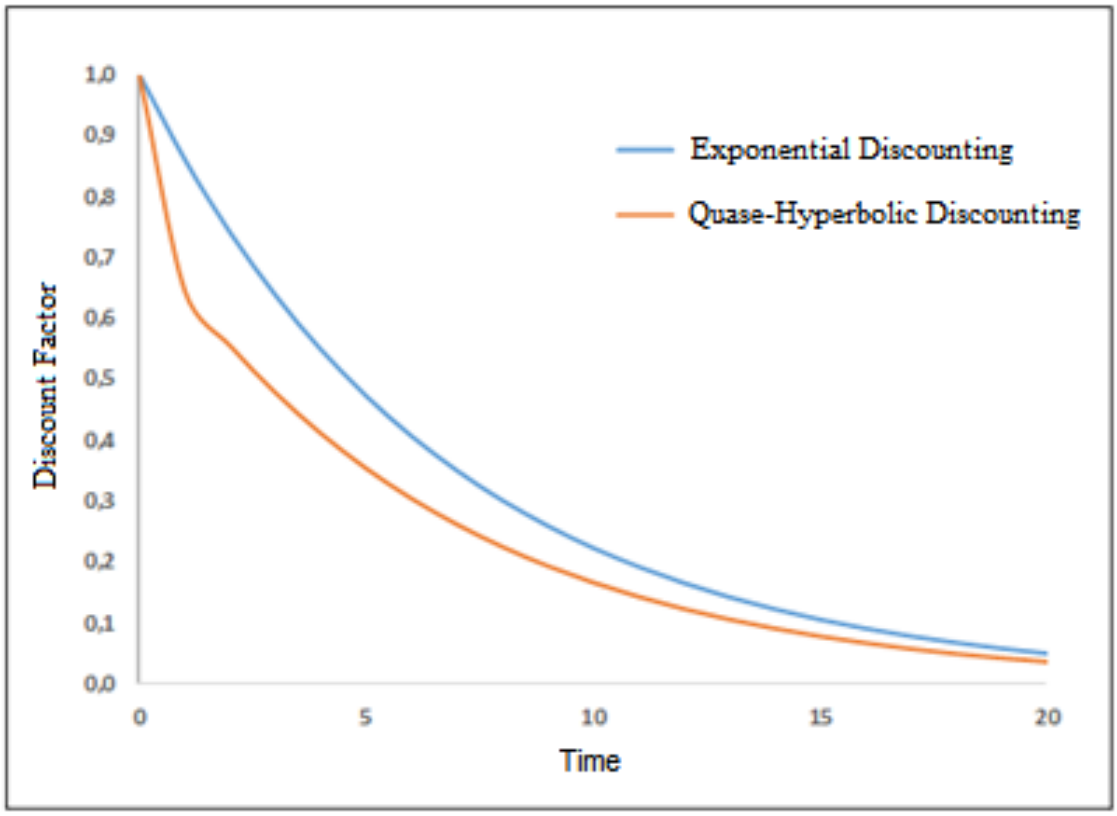

Figure 3 *Exponential vs. quasi-hyperbolic discounting*
Source: *Elaborated by the authors based on Benhabib et al. (2010).*

The quasi-hyperbolic discounting function *D(t)* to be used is the one defined in (4) (Benhabib et al., 2010). In this specification, a future reward is associated with a cost that is proportional to the value of the reward.

$$D(t)=\begin{cases}1, \text{if } t=0\\ \beta exp(-\delta t), \text{if } t>0\end{cases} \quad (4)$$

in which β is the coefficient representing the present bias and δ is the parameter for time preferences.

When β = 1, the quasi-hyperbolic specification decreases exponentially, with constant discounting. We can thus interpret β as a subject's preferences for the present, that is, the individual prefers immediate reward over all future rewards. The smaller β is, the greater the individual's impatience will be, that is, the greater their preference for the present will be (Liebenehm & Waibel, 2014).

2.2 Global Studies

International studies of differences in time preferences are rare. We can mention that of Wang et al. (2016), who analyzed time preferences in 53 countries, associating the results with Hofstede's (2001) cultural dimensions and macroeconomic variables. All the countries analyzed exhibited hyperbolic discounting patterns, where the immediate future has a higher discount rate than the distant future. Cultural factors contribute significantly to the temporal variation in discounting, even after controlling for economic factors, such as gross domestic product (GDP), the inflation rate, and the growth rate.

Rieger et al. (2015) conducted as large-scale international study in 53 countries. In all the countries, the authors found, on average, risk aversion in the gains area and a propensity for risk in the losses area. One interesting point was the big difference between the countries in the level of risk aversion, a fact not only explained by economic conditions, but also by Hofstede's (2001) cultural dimensions, notably individualism and aversion to uncertainty.

Rieger et al. (2017) estimated the cumulative prospect theory parameters in 53 countries and associated those parameters with Hofstede's (2001) cultural variables and GDP per capita, with emphasis on the weight function. The authors found a significant effect of individualism and aversion to uncertainty on probability distortion, even after controlling for GDP per capita. The greater the aversion to uncertainty and lower the individualism in a country, the lower the probability distortion was. In addition, the log of

GDP per capita showed to have a significant effect, where richer countries had a greater probability distortion than the poorest ones. Finally, it was also found that women distort probabilities more than men.

L'Haridon and Vieider (2019) carried out a global comparison of risk preferences in a sample of 2,939 subjects in 30 countries. Less developed countries tend to exhibit greater loss aversion (λ) than richer countries. In relation to demographic factors, women present greater sensitivity to the weight function.

Ruggeri et al. (2020) replicated the risk preference experiment in 19 countries with 4,098 individuals, merely adjusting the local currencies to test this experiment among different countries, and they were able to confirm the premises found by Kahneman and Tversky (1979), with 94% adherence in total – in 12 of the 13 theoretical comparisons replicated, there was even 100% replication in some of them. They concluded that even with heterogeneity of the countries and cultural relationships, the premises are valid.

2.3 Individual Studies in Developing Countries

Tanaka et al. (2010) surveyed the risk aversion and time preference profile of residents of rural villages in the north of Vietnam. The result of the analysis showed that the participants who had a higher educational level and age were more risk averse. On the other hand, family income was not correlated with risk preferences, but was with greater patience.

Nguyen (2011) developed a study that sought to estimate the risk and time preference of a group of fishermen in Vietnam. According to the researcher, the fishermen had lower risk aversion compared with inhabitants engaged in another type of profession; however, by adding the education variable, it was verified that the higher the inhabitant's educational level, the more risk averse he was. With regard to time, the author identified that older individuals with a higher income are more patient.

Tanaka and Munro (2014) conducted a study in the rural region of Uganda and concluded that individuals from more developed rural villages are more risk averse and less loss averse than inhabitants of less developed villages. Finally, the higher the level of family wealth, schooling, and age, the lower the loss aversion is. With relation to preference over time, the higher the average level of wealth of the village, government investment in local infrastructure, such as tarmacking, and the closeness of the village to the city, the greater the individual's patience is.

Liebenehm and Waibel (2014) made a simultaneous estimation of risk and time preferences with small farmers in West Africa. The authors identified that the higher the individual's income, the greater their loss aversion. Income was also associated with greater patience, which is consistent with other studies that have found a relationship between poverty and impatience (Tanaka et al., 2010; Nguyen, 2011). In addition, religiosity increases probability distortion and reduces loss aversion, which is an indirect indication of cultural influences. Finally, the authors detected a negative relationship between educational level and the discount rate (impatience).

Clot et al. (2017) conducted a study in Uganda to verify a possible relationship between impatience and risk aversion, by controlling demographic and financial variables. According to the authors, the results showed that the higher the level of the individual's impatience, the greater their risk aversion. In addition, the authors observed that the higher the level of wealth, measured by the size of land belonging to the worker, the lower their risk aversion. Finally, the higher the individual's age, the greater their risk aversion was.

2.4 The Relationship between Financial Literacy and Risk and Time Preferences

As seen by Potrich et al. (2015), financial literacy has been recognized as an essential skill and increasingly important in daily life, given the constant increase in the complexity of the environment in which we live. In particular, in Brazil, people lack financial literacy (Bruhn et al., 2013).

According to the Financial Education Association of Brazil (AEF-Brasil, 2019), actions to provide young people with financial knowledge have grown over the years, many of which have been carried out by the AEF-Brasil. In addition, as seen, the "Guidance for Financial Education in Schools" program stands out, which was built with the participation of the Ministry of Education (MEC), the National Union of Municipal Education Leaders (Undime), the National Council of Education Secretaries (Consed), and other educational and financial institutions over a year, coordinated by the Brazilian Securities and Exchange Commission (CVM).

The initiatives that the government has adopted over the years to incentivize the construction of a financial and entrepreneurial culture in young people have a direct impact on our society, including because, as Muñoz-Murillo et al. (2020) indicate, financial literacy can shape an individual's financial behavior, affecting their personal finances (domestic budget, investments, loans, and plans for the future).

Some national and international studies were gathered that relate with the theme discussed throughout the paper,

but it is worth remembering that the association between financial education and the low-income university public (participants in the University for All Program – ProUni) using the proposed methodology based on prospect and hyperbolic discounting theory (involving risk and time preferences) is something that is yet to be analyzed in the academic arena.

With relation to financial literacy and preference over time, few studies were found, the most relevant being that of Meier and Sprenger (2013). The research intends to understand the correlation between previous financial knowledge, preference over time, and the propensity to acquire more financial information regarding credit products. The authors identified that those who have previous financial knowledge have a greater level of patience. In addition, the most patient are more willing to take part in a credit counseling program.

Almenberg and Dreber (2015) analyzed the reason for the greater participation of men in the stock market than women and concluded that this difference decreased when the basic financial knowledge variable was included. The inclusion of risk aversion as a control variable did not modify the results, which may be an indication of the greater importance of financial education.

The study of Bannier and Neubert (2016) analyzed the relationship between actual and perceived financial knowledge, risk aversion, and investor behavior between men and women. The authors reached the conclusion that investments in basic assets are related to actual and perceived knowledge in men, but only to perceived knowledge in women. On the other hand, investments in sophisticated assets are only related to perceived knowledge, with a greater impact on women. Including risk aversion did not explain investment in advanced financial assets by women, despite the overall finding that they are more risk averse than men.

Torga et al. (2018) analyzed how social and psychological aspects of university students can have an impact on decision making considering a simulated training environment. The experiment was developed in the Stock Market Operations discipline, with the use of software such as Metatrader and TradingView during the classes. The sample was composed of 32 graduate and eight post-graduate students. The questions in the survey used sought to understand which criteria motivated the students to take decisions in the individual, social, and emotional dimensions, as well as the financial education level. The result of the questions on religion and financial education did not allow for a conclusion to be reached regarding the aspects of highest or lowest risk tolerance.

Kich et al. (2018) studied the relationship between financial education level and behavioral biases of the framing effect, mental accounting, and loss aversion in university students at the Federal University of Santa Maria. The study sample included 568 graduate students following the model proposed by Kahneman and Tversky (1997). The authors verified that the presence of behavioral biases is verified in greater quantity in the low financial education level group (strong presence of loss aversion and mental accounting).

Pinto and Rossato (2019) sought to analyze the propensity for indebtedness in the university context. The research was developed at the Federal University of Santa Maria with a total of 721 respondents from various graduate and post-graduate courses, as well as teachers and other staff. They verified that the men were the ones with the best financial education and had a lower propensity for indebtedness and consequent risk taking. The women with less financial education were more prone to indebtedness. It was also perceived that older people and those with a higher educational level tend to have a better financial education.

3. METHODOLOGY

3.1 Description of the Sample and Selection

The data gathered through the economic experiment were on students of a private higher education institution (HEI) in Rio de Janeiro (Catholic Pontifical University of Rio de Janeiro – PUC-Rio), regularly enrolled in graduate courses and with socioeconomic study scholarships, that is, scholarships of the philanthropic type, of the institution or ProUni. The research was conducted with 54 students and 110 lotteries, as will be described.

PUC-Rio is a community-based, philanthropic, and non-profit higher education institution. Times Higher Education, one of the institutes that assess universities at a global level, classified PUC-Rio among the 10 best universities in Latin America, having reached 7th position in the general ranking. The same institute classified it as the 4th best university in Brazil and the best private university in the country in 2018. The university currently has 17,900 students (PUC-Rio, 2021).

3.2 Conducting the Risk and Time Experiment

The participants were exclusively students of the graduate course in administration and were divided into groups of up to five people, each one participating for between one and one and a half hours. During the application of the test, it was explained that in the experiment closed-type questionnaires had to be completed, with multiple choice questions: one for measuring the level of financial literacy – adapted from Krich et al. (2018) – and another for verifying behavior in relation to risk and time – adapted from Liebenehm and Waibel (2014).

The participants were orientated with regard to the game before the application and any questions were answered. After the participants signed the consent form of the Ethics Council of the Institution, they began the experiment by making choices of risk lotteries. Additionally, their enrollment data at the university were collected: sociodemographic, scholarship type, and family income per capita.

The experiment had three blocks with options A and B: the first and the second with 14 risk lotteries and the last with seven, totaling 35 lotteries. Each line of the lottery had a probability of occurrence, but the interviewee could not clearly see the exact value of each one. Each probability of the event was represented by the size of the "slice of pie" on the chart, as can be observed in Figure 5.

The objective was to identify at what moment the participant would change lottery A for lottery B or if they would prefer to continue in lottery A, which was the starting point of the experiment. For that, the researcher put the lottery A disc on the table, and with relation to lottery B, he presented each one of the options, without the participant knowing what the subsequent values would be. This procedure was carried out in the three blocks of risk lottery options, until the 35th lottery. Figures 4 and 5 illustrate the process.

Figure 4 *General overview of the financial experiment*
Source: *Elaborated by the authors.*

Figure 5 *First lottery pair from the first part of the risk aversion estimation.*
Source: *Elaborated by the authors.*

In the time experiment, the individual would also make choices, but with relation to the real fixed values, without occurrences of probabilities. In addition, unlike what occurred in the risk experiment, the objective in the time experiment was to identify at what moment the participant would change the value that could be received in lottery B for the value that could be received in lottery A, given the time interval considered.

This analysis method was based on the Switching Multiple Price List (SMPL), as suggested by Harrison and Rutström (2008) and Andersen et al. (2008), whose advantage is that it reinforces a monotonic change. Each respondent receives a sequence of binary choices to be made, generally asking in which option they wish to change from one lottery to another.

With relation to the number of time lotteries, there were 15 blocks in total, each one with five value options for lottery A, and one fixed value in lottery B, besides two time intervals to be considered, in which the "today" was fixed in lottery A and, in each block, the temporality of B was modified, as can be observed in Figure 6. In total there were 75 pairs of lotteries to be used, with their values varying between R$ 12.50 and R$ 750.00 and the temporality varying between today, 3 days, 1 week, 2 weeks, 1 month, and 3 months.

Figure 6 *First line of the first temporal estimation lottery.*
Note: *Hoje = Today; 1 semana = 1 week.*
Source: *Elaborated by the authors.*

The experiment lasted a total of 25 to 30 minutes for each individual and each group had six students, totaling nine groups. After the students in a particular group participated in the financial experiment, the draw was carried out. The values to be used referred to 10% of the rewards that could be chosen in the 75 time lotteries available, that is, the minimum amount to be received was R$ 1.25 and the maximum amount was R$ 75.00.

To obtain the data from the sample with relation to the level of financial literacy, a survey was conducted using a questionnaire that was built and validated in Brazil by Potrich et al. (2018). That questionnaire was answered by the participants after doing the financial experiment and before the draw was carried out.

3.3 The Econometric Model

In accordance with Harrison and Rutström (2008), the method used was structural estimation, using maximum likelihood estimators, which involve choosing a latent variable, ∇EU , defined in (5), from a pair of lotteries. This variable is based on the individual's latent preference, in which only the participant knows their choice option before actually choosing it.

Thus, it is assumed that the utility function applied to prospect theory will be used, which, according to Liebenehm and Waibel (2014), takes the form defined in equation 5.

$$U_i^j = PT_i^j\left(X_i;Z_j\right)D_i\left(t;X_i\right)+\varepsilon_i^j \qquad \textbf{5}$$

in which i is the respondent, j is the decision taken in the risk and time experiments, $PT_i^j\left(X_i;Z_j\right)$ is the utility function from the perspective of prospect theory, $D_i(t;X_i)$ is the quasi-hyperbolic discounting, and ε_i^j is the error term, normally independent and identically distributed.

As mentioned, the structural estimation uses the latent variable ∇EU, known as Fechner's index. This binary choice index is linked to the interviewees' answer pattern, through the cumulative probability function $(\varphi(\nabla U_j^i)$, as seen in equation 6.

$$\nabla EU_j^i = U_i^{B;j} - U_i^{A;j} \qquad \textbf{6}$$

Thus, the first function to be estimated, including the parameters of the utility function from the perspective of prospect theory (α, σ, and λ) and the time preference parameters (β and δ), can be expressed according to equation 7.

$$lnL_i\left(\alpha,\sigma,\lambda;\beta,\delta;X_i;Z^j;y_i^j\right)=\sum_{j=1}^{n}\left\{\left[ln\ \phi(\nabla U_j^i\left|y_j^i=1\right.\right]+\left[\ln\phi(\nabla U_j^i\left|y_j^i=0\right.\right]\right. \qquad \textbf{7}$$

in which α, σ, and λ are the parameters linked to prospect theory and have the purpose of revealing the risk and loss aversion, and β and δ are related to quasi-hyperbolic discounting theory and are linked to time preference. In addition, y_j^i are the choices captured by the students, $y_j^i=1$, when the choice is made in lottery B, and $y_j^i=0$, when it is made in lottery A. Finally, X_i are the sociodemographic characteristics.

Two types of model were estimated: the heterogeneous one and the heterogeneous one with the FLR moderation variable. The first aims to verify the correlation between the risk and time parameters and the sociodemographic characteristics (gender, age, income) and the second aims to verify the correlation between the parameters and all of the sociodemographic characteristics (gender, age, income, financial literacy rate).

4. RESULTS

By analyzing the characteristics of the sample of 54 students in Table 1, it was possible to note than most are women (38 women and 16 men), with an average age of 22 years old and average income of R$ 1,749.11. The average perceived financial literacy rate was 0.59, which shows, according to the classification of Potrich et al. (2018), that the sample in this study has a high level of financial literacy. The FLI variable has a mean of 13.24, which equates to the mean age x mean financial literacy (22.44 x 0.59).

Table 1
Statistical Summary

Variable	Description	Mean	Standard deviation
Individual characteristics	-	-	-
Age	Age in years	22.44	3.73
Income	Income in reais	1,749.11	903.87
Financial Literacy Rate	-	0.59	0.50
FLI	Age x financial literacy rate	13.24	11.34
N	54	-	-

Source: *Elaborated by the authors.*

4.1 Heterogeneous Model

The first analysis was conducted with relation to the probability distortion function, controlling demographic variables. It can be perceived in Table 2 that the α found in the sample is equal to 0.147, which enabled us to conclude that the participants distort the probabilities of the events.

Table 2
Estimated model with sociodemographic characteristics of age and income

Parameters	Estimation	Standard deviation	Confidence interval	
			Lower than 95%	Higher than 95%
Probability weight (α)	0.147	0.293	-0.426	0.721
Gender	-0.117	0.063	-0.241	0.007
Age	-0.009	0.006	-0.021	0.003
Income	0.039	0.042	-0.426	0.721
Risk aversion (σ)	0.454	0.157	0.145	0.762
Gender	-0.013	0.033	-0.077	0.052
Age	-0.008	0.003	-0.014	-0.003
Income	0.002	0.021	-0.038	0.043
Loss aversion (λ)	1.809	1.101	-0.349	3.967
Gender	-0.191	0.318	-0.814	0.433
Age	-0.026	0.040	-0.104	0.052
Income	-0.061	0.191	-0.436	0.313
Time preference (δ)	0.004	0.002	-0.001	0.008
Gender	0.000	0.000	-0.001	0.000
Age	0.000	0.000	0.000	0.000
Income	0.000	0.000	-0.001	0.000
Bias of the present (β)	0.969	0.288	0.582	1.713
Gender	0.028	0.064	-0.097	0.153
Age	0.011	0.009	-0.006	0.029
Income	-0.035	0.041	-0.116	0.045

Note: *N = 5,940 (number in the sample = 54); Log pseudolikelihood = -2,266.644.*
Source: *Elaborated by the authors.*

The coefficients of risk aversion (σ) and loss aversion (λ) are 0.454 and 1.809, respectively, indicating that the sample in this study has risk and loss aversion, as was demonstrated along general lines by Kahneman and Tversky (1979). Comparing with the studies in developing countries, it is perceived that only the study of Liebenehm and Waibel (2014) found lower risk aversion and loss aversion than those of the present study. This may be a still unexplored indication that individuals from low-income urban populations in emerging countries could have similar risk and loss aversion parameters to those of rural populations in developing countries.

The study of Rieger et al. (2017) can serve as a basis for comparison with this study, though a simultaneous estimation with time preferences was not carried out. The authors estimated all the parameters from cumulative prospect theory, both in the gains and in the losses area for various countries, and Brazil was not included. If the mean values (area of gains and losses) are taken from that study for countries in Latin America, we have the following results described in Table 3.

Table 3
Comparison of this study with the study of Rieger et al. (2017)

	σ	λ	α
Argentina	0.58	1.11	0.58
Brazil (this study)	0.45	1.81	0.15
Chile	0.72	1.72	0.62
Colombia	0.40	1.26	0.59
Mexico	0.34	1.14	0.53

Note: *The parameters from the study of Rieger et al. (2017) refer to the mean in the area of gains and losses.*
Source: *Elaborated by the authors.*

Despite the methodology used for calculating the parameters being different in terms of econometric models, it can be deduced that the risk aversion of our sample is lower than that of most countries, with the exception of Mexico. The loss aversion and probability distortion, in turn, are higher than in the other countries. Two explanations are plausible: one is that our sample is low-income and mostly female and the other is that in our analysis we included the joint estimation of risk and time preferences.

The last analysis was conducted with relation to the time parameters, and in it a δ value of 0.004 and β value of 0.969 were found. According to Liebenehm and Waibel (2014), when the discount rate (δ) is higher and the present bias parameter (β) is lower, the impatience is greater. The estimators of the time preference parameters in this study suggest that the low-income students have a lower discount rate and greater preference for the present than found in the studies of Tanaka et al. (2010), Nguyen (2011), and Liebenehm and Waibel (2014). The results imply that our sample is more patient than those of the countries analyzed. Despite being a sample of low-income people, it should be considered that, unlike the samples discussed, they receive some type of scholarship, which could be a reason for delaying immediate consumption.

Proceeding with the influence of the demographic variables, it is noted that the women distort the probabilities more, they are more risk and loss averse, and they are more patient than the men, which is consistent with the studies conducted at a global level (Rieger et al., 2017; Falk et al., 2018; l'Haridon & Vieider, 2019). With relation to age, in turn, the relationship found with the probability distortion parameter was negative, implying that older people distort the probability more in our sample, which is consistent with the study of Booij et al. (2010), conducted with a large sample in the Netherlands. However, given that our sample is largely composed of younger people, the results should be viewed with caution.

Younger individuals tend to also be more risk averse, but they have less loss aversion. It is worth remembering that risk and loss aversion are two different constructs within prospect theory. An individual may be risk averse, but have less loss aversion. Younger people within our low-income universe tend to be more patient. It is worth remembering that some studies show an inverted U shape in the relationship between age and risk aversion (Falk et al., 2018), and others, such as ours, show an inverse relationship (Tanaka et al., 2010; Cassar et al., 2017).

Analyzing income, it is observed that the higher the income, the lower the risk aversion. On the other hand, a higher income is associated with lower probability distortion, lower risk aversion, and greater patience. The relationship between patience and income has been confirmed in prior studies, as previously mentioned (Tanaka et al., 2010; Nguyen, 2011; Liebenehm & Waibel, 2014). In relation to our study, conducted with low-income students, the results provide an indication that a small increase in income within that group is associated with a greater level of patience, making decisions more rational.

4.2 Moderation Analysis

With the aim of analyzing how the interaction of the demographic variables of age and income behaved in relation to the risk and time estimators with the inclusion

of financial education, the moderating variable FLI (Age x Financial Literacy Rate) was added to the original model (heterogeneous model). This variable is the multiplication of the level of financial literacy construct with age. In Table 4, it is possible to observe the result of the correlations. The inclusion of age is due to the fact that it was shown to be crucial in the decline of financial education (Finke et al., 2017).

Table 4
Model estimated with the demographic characteristics and financial literacy

Parameters	Estimation	Standard deviation	Confidence interval	
			Lower than 95%	Higher than 95%
Probability weight (α)	0.116	0.304	-0.479	0.712
Gender	-0.119	0.060	-0.236	-0.001
Age	-0.007	0.007	-0.021	0.007
Income	0.045	0.045	-0.043	0.133
FLR[a]	-0.004	0.002	-0.009	0.000
Risk aversion (σ)	0.446	0.155	0.144	0.749
Gender	-0.011	0.030	-0.071	0.049
Age	-0.008	0.003	-0.013	-0.002
Income	-0.072	0.183	-0.430	0.287
FLR[a]	-0.147	0.140	-0.042	0.013
Loss aversion (λ)	1.975	1.107	-0.195	4.144
Gender	-0.234	0.342	-0.903	0.436
Age	-0.021	0.039	-0.098	0.056
Income	-0.072	0.183	-0.430	0.287
FLR[a]	-0.015	0.014	-0.042	0.013
Time preference (δ)	0.004	0.002	-0.001	0.008
Gender	0.000	0.000	-0.001	0.000
Age	0.000	0.000	-0.001	0.000
Income	-0.001	0.000	-0.001	0.000
FLR[a]	0.000	0.000	0.000	0.000
Bias of the present (β)	0.965	0.279	0.595	1.689
Gender	0.024	0.058	-0.089	0.138
Age	0.009	0.008	-0.007	0.025
Income	-0.035	0.040	0.113	0.044
FLR[a]	0.003	0.002	-0.001	0.008

Note: *N = 5,940 (number in the sample = 54); Log pseudolikelihood = -2,257.455.*
FLI[a]: Age x Financial Literacy Rate.
Source: *Elaborated by the authors.*

Observing the inclusion of the FLI variable, it is noted that the sign of all the parameters does not change and only a small change in magnitude was found. Through Table 4 it is possible to perceive that the higher that variable is, the greater the probability distortion, the greater the risk aversion, the lower the loss aversion, and the greater the patience level.

In the case of probability distortion and loss aversion, a positive influence of financial education is noted, which leads to a smaller distortion and lower loss aversion – a lower interaction coefficient than the age coefficient in absolute terms.

Financial education, in turn, appears to increase the level of risk aversion and not influence the level of patience. The relationship between patience and financial knowledge was already found by Meier and Sprenger (2013) and it is an important finding of this study for our low-income sample.

5. CONCLUSION

This study aimed to identify the risk and time preference of low-income university students. Thus, understanding the behavior of this sample in relation to the choice situations they were placed in became crucial for concluding the study.

In light of this, the value and weight functions of prospect theory and the quasi-hyperbolic discounting function were applied within a maximum likelihood methodology to estimate the risk (α, σ, and λ) and time (δ and β) parameters, correlating them with sociodemographic characteristics and financial knowledge. In all the models, comparisons were made with studies conducted at a global level and in other developing countries, enabling us to more accurately interpret the results found.

In general, it is noteworthy that the participants distort the probabilities of the events and they are risk and loss averse, as well as being patient. With relation to the demographic variables, it is noted that women distort the probabilities more and they are more risk and loss averse, as well as being more patient than men. With relation to age, in turn, older people tend to distort the probability more.

Younger individuals tend to be more patient and more risk averse, but they have lower loss aversion. Analyzing income, it was observed that the higher the income is, the lower the risk aversion. On the other hand, a higher income is associated with a lower probability distortion, lower risk aversion, and greater patience. In the case of probability distortion, there is a positive influence of financial education, which leads to less distortion.

Despite the relatively small sample, the number of observations of 5.940 lotteries with 54 participants enabled the application of parametric techniques, in line with other studies. However, we should reaffirm that this is a pilot study, the first of its type in Brazil. It opens the doors to the relationship between poverty and risk and time preferences being better discussed in Brazil. Our study demonstrates the importance of financial education as a means of reducing agents' probability distortion. This is crucial, given that probability distortion has been shown to be the most important part of prospect theory in financial agents' behavior (Barberis & Huang, 2008; Barberis et al., 2016). Greater financial education could induce less probability distortion, which would enable greater rationality of agents and cause a small saving, less credit card use, and greater effectiveness of microcredit and microinsurance policies.

Future studies could incorporate an in-depth analysis of cultural dimensions in the explanation of the results obtained in Brazil. Brazil, according to Hofstede's (2001) classification, is considered a collectivist country with high aversion to uncertainty. Using the classification of Gelfand et al. (2011), it is classed as having less severe social norms. Understanding how that affects risk and time preferences in a bigger sample could help to better understand their cultural determinants.

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