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THE IMPACT OF LOCUS OF CONTROL ON THE INCIDENCE OF THE SUNK-COST EFFECT: A QUASI-EXPERIMENTAL APPROACH

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ABSTRACT

This article aimed to analyze the impact of locus of control on the influence of the sunk-cost effect on the willingness to invest in unprofitable projects. To achieve this objective, a quantitative study was conducted using a quasi-experimental design with 192 students from various business courses at a university in the Brazilian Midwest. The results indicated that the presence of the sunk-cost effect, expressed both in monetary terms and in terms of project completion, increased students' willingness to continue investing in unprofitable projects. Contrary to expectations, it was found that levels of locus of control were not associated with the incidence of the sunk-cost effect or with the willingness to invest in unprofitable projects, suggesting that individuals' perceived control over present and future events does not mitigate or amplify the impact of heuristic biases in investment decisions. As practical implications, the study reinforces the importance of implementing formal investment evaluation mechanisms in organizations. In the educational context, the findings suggest a need to revise teaching strategies regarding economic rationality and to promote interdisciplinary integration in business education, aiming to raise students' awareness of how cognitive biases, especially the sunk-cost effect, can influence financial decision-making.

Keywords: Sunk-Cost. Locus of Control. Students. Prospect Theory.

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1 INTRODUCTION

The decision-making process of managers in business contexts is characterized by the need for a comprehensive analysis of highly complex internal and external factors, often under conditions of limited information access (Nobre et al., 2022). This mismatch between environmental complexity, information availability, and the imperative to make decisions creates fertile ground for cognitive biases, which can compromise both rationality and decision quality (Nobre et al., 2022; Paraboni et al., 2019). A typical case involves the consideration of sunk costs, leading to the sunk-cost effect, defined as the tendency of an individual to continue an endeavor once prior investments of money, effort, or time have been made (Arkes & Blumer, 1985). This effect is present, for example, in investment decisions such as whether to invest in a production line or keep a business unit operational (Altoé et al., 2013; Fennema & Perkins, 2008).

Previous empirical studies conducted with business students reinforce the presence of the sunk-cost effect in organizational decision-making contexts (Altoé et al., 2013; Grejo et al., 2015; Meireles et al., 2019; Paraboni et al., 2019; Rengel et al., 2019; Rover et al., 2009; Santos et al., 2021; Silva & Domingos, 2010). Multiple explanations for the occurrence of the sunk-cost effect exist in the literature, including loss aversion (Friedman et al., 2007), waste aversion (Arkes & Blumer, 1985), and self-justification (Staw, 1976). Current understanding suggests that these heuristic principles are inherent to humans' intuitive thinking, which requires less cognitive effort and allows decisions to be made in complex scenarios where full information processing is practically impossible (Rover et al., 2009; Nobre et al., 2022). This study seeks to advance understanding of factors that may impact this dynamic, specifically regarding the influence of locus of control.

Locus of control is defined as the extent to which individuals perceive that they have control over their lives (Duffy, 2010). It is argued that this construct may be important in investment decision-making (Tavares & Fernandes, 2017) and that some cognitive biases may be influenced by an individual's locus of control (Silva & Yu, 2009). Theoretically, it is expected that locus of control could affect the willingness to invest in unprofitable projects and the impact of the sunk-cost effect, due to the illusion of control (Langer, 1975) an overestimation of the probability of success induced in skill-based situations (e.g., management, decision-making), amplified by the certainty effect and waste aversion (Arkes & Blumer, 1985).

Having defined the problem (presence of sunk-cost in organizational decisions) and the research gap (possible factors affecting the sunk-cost dynamic in this context), the research question is formulated as follows: "What is the effect of locus of control on the influence of the sunk-cost effect on the willingness to invest in unprofitable projects?" The main objective is to analyze the impact of locus of control on the influence of the sunk-cost effect on investment decisions in unprofitable projects.

This study contributes to the literature on decision-making biases in organizational contexts by exploring the role of locus of control in the consideration of sunk costs. Investigating this relationship can provide insights for educational policies and support the development of specific competencies for business professionals. Practically, the study highlights the importance of implementing formal decision-support mechanisms and evaluating the effectiveness of teaching economic rationality in higher education business programs.

2 THEORETICAL FRAMEWORK

2.1 Sunk-Cost Effect

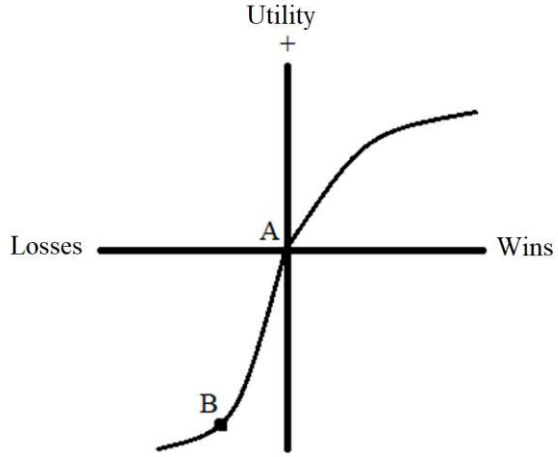
The sunk-cost effect is defined as the tendency of an individual to continue a past endeavor due to prior investments of money, time, or effort (Arkes & Blumer, 1985; Sofis et al., 2015). It is a phenomenon of "escalation," in which a person persists in an action despite expected negative

outcomes (Sofis et al., 2015). Such behavior is considered irrational, as only incremental costs should influence present investment decisions (Arkes & Blumer, 1985; Clikeman & Stevens, 2019).

Susceptibility to the sunk-cost effect is understood to stem from the inherent structure of human cognition, which favors intuitive, rapid, and automated judgments (Rover et al., 2009; Nobre et al., 2022). The literature provides both rational and psychological explanations for its occurrence, with greater emphasis on the latter, including loss aversion, self-justification, and regret aversion (Staw, 1976; Thaler, 1980; Arkes & Blumer, 1985; Friedman et al., 2007). The dynamics of these justifications are generally explained by Prospect Theory (Kahneman & Tversky, 1979).

Prospect Theory posits that individuals treat gains and losses differently and that risk preference is reference-dependent, influenced by the utility derived from past outcomes (Kahneman & Tversky, 1979; Thaler, 1980). An individual situated in the "loss domain" (point B in Figure 1), a scenario typically associated with past sunk costs, is more likely to continue investing because the marginal utility of potential gains at this point exceeds the marginal disutility of incremental losses. Moreover, abandoning a project under these circumstances entails acknowledging a loss, which is particularly aversive (Arkes & Blumer, 1985). Therefore, discontinuing a project tends to generate negative emotions (Arkes & Blumer, 1985) and cognitive dissonance (Friedman et al., 2007), leading individuals to favor riskier decisions over confronting these aversive feelings. Rational explanations for such behavior are often grounded in the protection of personal reputation (Friedman et al., 2007; Silva, Callado & Câmara, 2024).

Figure 1
Utility Function in Prospect Theory



Source: Adapted from Arkes and Blumer (1985).

Empirical studies indicate that business students tend to consider sunk costs in their decisions (Rover et al., 2009; Silva & Domingos, 2010; Altoé et al., 2013; Meireles et al., 2019; Paraboni et al., 2019; Santos et al., 2021), although to a lesser extent compared to students in other fields, such as psychology (Fennema & Perkins, 2008). This generally suggests that formal knowledge acquired in courses on economics, cost accounting, and finance is not being effectively integrated and applied by students in these situations. Alvarenga and Vosgerau (2015) argue that, in general, individuals are not aware of the influence of such biases during the decision-making process. Based on this, it is expected that business students will demonstrate a willingness to invest in unprofitable projects when sunk costs have already been incurred. Accordingly, the following hypothesis is proposed:

H1: *The presence of the sunk-cost effect positively impacts the willingness to invest in unprofitable projects.*

2.2 Locus of Control

Locus of control is defined as an individual's perception of control over the events in their life (Silva & Yu, 2009; Duffy, 2010). Individuals with a higher locus of control believe and expect that their actions can influence external events and their outcomes (Slagsvold & Sorensen, 2008). This concept appears in the literature under various terms, including self-efficacy, fatalism, locus of control, and sense of control (Mirowsky & Ross, 1991; Silva & Yu, 2009). Although it has been relatively underexplored in finance studies (Tavares & Fernandes, 2017), Silva and Yu (2009) argue that certain cognitive biases may depend on an individual's personal locus of control.

Locus of control can be divided into two dimensions: beliefs about control over the external environment and beliefs about oneself (Slagsvold & Sorensen, 2008). The authors suggest that in behavioral studies, these dimensions can be merged or represented unidimensionally, as they tend to influence each other through behavior and the attribution of successes and failures (Slagsvold & Sorensen, 2008).

This study proposes that individuals with a higher locus of control exhibit a greater willingness to invest in unprofitable projects. This relationship is grounded in the phenomenon of the illusion of control, defined as an overestimation of the probability of success (Langer, 1975) stimulated by an individual's belief in their ability to influence outcomes (Centeno et al., 2024). The illusion of control is expected to occur in situations where an individual's skill can affect outcomes (Langer, 1975), an element present in managerial decision-making. Previous studies support a positive relationship between the illusion of control and risk propensity (Abdin et al., 2022), as well as in organizational decisions (Aschbacher & Kroon, 2025; Borges & Janissek-Muniz, 2021). Thus, individuals with a higher locus of control are likely to overestimate their ability to influence future results of projects with lower expected returns at a given moment. Accordingly, the following hypothesis is proposed:

H2: *Individuals with a higher locus of control tend to exhibit a greater willingness to invest in unprofitable projects*.

Individuals with a higher locus of control tend to blame themselves or feel more responsible for their outcomes (Lachman & Weaver, 1998). This sense of self-blame represents a form of rejection of helplessness in the face of adversity (Mirowsky & Ross, 1990), which is considered a relevant trait for coping with stress and the discomfort inherent in long-term asset or project investment decisions (Silva & Yu, 2009). Although no prior studies have directly linked locus of control to the incidence of the sunk-cost effect, loss aversion (Friedman et al., 2007) and waste aversion (Arkes & Blumer, 1985) are recognized as the main drivers explaining persistence in sunk-cost situations. Additionally, the certainty effect tends to be present in these contexts, increasing the likelihood that individuals prefer the possibility of future losses rather than accepting losses already incurred. Thus, it is expected that individuals with a higher locus of control experience these feelings (loss aversion and waste aversion) more intensely, and their overestimation of their ability to influence outcomes amplifies the certainty effect, making them more likely to continue investing in unprofitable projects. Based on this reasoning, the following hypothesis is proposed:

H3: *The influence of the sunk-cost effect on the willingness to invest in unprofitable projects is greater for individuals with a higher locus of control than for those with a lower locus of control.*

3 METHODOLOGICAL PROCEDURES

3.1 Participants

The study included 192 business students (51% male, n = 98; 1% non-binary, n = 2) aged between 18 and 41 years (M = 21.9; SD = 4.456). Of the total sample, 22.9% were studying Economics (n = 44); 15.1%, Administration (n = 29); 47.4%, Accounting (n = 91); and 14.6%, Management Technology (n = 28). Regarding their semester of study, 44.3% were in the first or second semester (n = 85); 33.8% in the third or fourth semester (n = 65); 6.8% in the fifth or sixth semester (n = 13); and 15.1% in the seventh or eighth semester (*n* = 29).

3.2 Instruments

Willingness to Invest in Unprofitable Projects (DIPNR: dependent variablemeasured using responses to the experimental scenario developed by Domingos (2007). This hypothetical scenario places the respondent in the position of a company vice-president, who must decide whether to allocate additional financial resources to a project with low potential returns, given that the company is aware that a competitor already has a marketing project for a similar product with higher quality and lower cost. Compared to the original instrument, the scale was adapted to range from -5 to 5 to reduce response variance and make a lack of willingness to continue investing in the project more evident through the inclusion of negative numbers (see Appendix A).

***Locus of Control (ISC; independent variable*)**: Measured using the instrument and procedures developed by Tavares and Fernandes (2017), this instrument aims to assess an individual's perception of their locus of control (Mirowsky & Ross, 1991; Tavares & Fernandes, 2017). The questionnaire consisted of eight statements, rated on a scale from -2 to 2 (excluding zero). The statements were: (1) "I do no planning; if things are meant to happen, they will happen"; (2) "Good things that happen to me are mainly due to my luck"; (3) "I am responsible for my own success"; (4) "I can accomplish anything I set my mind to"; (5) "Most of my problems are due to bad situations"; (6) "I have little control over the bad things that happen to me"; (7) "Bad events in my life result from mistakes I have made"; and (8) "I am responsible for my own mistakes." The responses to these statements were used to calculate the Locus of Control Index (ISC), following the procedures outlined in equations (1), (2), and (3). In these equations, "IBom" and "IRuim" represent the individual's perceived control over positive and negative events, respectively; "AF(x)" denotes the score for statement "x," and "ISC" represents the Locus of Control Index, the variable used in the model.

$$IBom = \frac{(AF_3 + AF_4) - (AF_1 - AF_2)}{2} \quad (1) \qquad IRuim = \frac{(AF_7 + AF_8) - (AF_5 - AF_6)}{2} \quad (2)$$

$$ISC = \frac{IBom + IRuim}{2} \quad (3)$$

***Sunk-Cost Effect* ($ESC_{Imp/Exp}$; manipulated independent variable):** Embedded within the context of the experimental scenario adapted from Domingos (2007), the presence or absence of the "sunk-cost effect" variable was manipulated through the details of the hypothetical scenario. The absence of the sunk-cost effect was operationalized by creating a "neutral" scenario, in which no information about any prior investment was provided. The presence of the sunk-cost effect was operationalized by including information regarding project completion (ESC_{Imp}; "implicit" scenario") and financial resources already invested (ESC_{Exp}; explicit" scenario") (see Appendix A). The variables ESC_{Imp} e ESC_{Exp} are dummy variables, coded as zero if the participant belongs to the control group or one (1) if assigned to the "implicit" or "explicit" scenario, respectively.

The distinction between the "explicit" and "implicit" sunk-cost scenarios is justified because past irrecoverable costs are not necessarily realized solely in financial terms (see the concept of the sunk-cost effect presented in the theoretical framework). Moreover, there are theoretical reasons for implementing this separation. Soman (2001), for instance, identifies three fundamental differences between time and monetary investments: (i) time cannot be substituted or recovered; (ii) time is not easily aggregated like financial resources; and (iii) accounting for financial resources is a common human practice, whereas accounting for time is not (Soman, 2001).

3.3 Data Collection Procedures

Regarding its purpose, process, outcome, and logic, this research can be classified as explanatory, quantitative, applied, and deductive, respectively (Collis & Hussey, 2021). In terms of operationalization strategy, it is a quasi-experiment. Data were collected in person at a public higher education institution in the Central-West region of Brazil between September 22 and October 3, 2023. The data collection instrument was administered in classrooms, following prior arrangements with the instructors responsible for the courses. Participants received standardized instructions for completing the instrument (delivered according to a pre-established script by a single researcher) and were instructed not to communicate during the experimental task. Ethical procedures included obtaining a signed Informed Consent Form from all participants, ensuring anonymity and other participant rights.

The experimental task was divided into three stages: (i) providing demographic information (gender, age, course, and semester); (ii) completing the instrument measuring locus of control; and (iii) engaging with the hypothetical scenario. To enhance the reliability of the data collection process, measures were implemented to address threats to internal and external validity, which are detailed in Table 1.

Table 1
Coping Measures – Threats to Internal and External Validity of the Experiment

Threat	Type	Definition	Coping Measures
Maturation	Internal	Changes in participants due to the passage of time (e.g., fatigue and hunger)	Short duration of the data collection process.
History	Internal	Environmental changes during the experiment that may affect participants	Single measurement over a brief period of time.
Testing	Internal	Possibility of prior tests interfering with subsequent tests	Experiment characterized as between-subjects.
Subject Mortality	Internal	Sample loss	In-person experiment.
Instrumentation	Internal	Lack of consistency among data collection instruments	Each variable dimension was measured homogeneously.
Selection	Internal	Method of group selection	Groups were composed randomly.
Statistical Regression	Internal	Consequence of selecting participants for groups based on extreme scores	Groups were composed randomly.

Resentment	Internal	Different experimental treatments and their impacts on individual motivation	Standardized data collection procedure.
Population Validity	External	Possibility that the sample size does not represent the population	Adherence to all assumptions (data analysis technique) and the minimum sample size (inference validation).
Ecological Validity	External	Reliability and representativeness of the hypothetical scenario	Use of instruments with prior empirical validation.
Temporal Validity	External	Generalization of the data over time	Cross-sectional experiment (specific point in time)

Source: Adapted from Smith (2003).

To ensure the randomness of group composition and, consequently, the absence of interference from potential alternative explanations, the effect of sociodemographic variables (gender, semester, and course) on the dependent variable was tested using a means comparison (Kruskal-Wallis test). The results indicated no effect of gender [$X^2(2) = 4.214$; $p = 0.122$], semester [$X^2(3) = 0.009$; $p = 1.000$], or student course [$X^2(3) = 2.922$; $p = 0.404$] on the disposition to invest in unprofitable projects, suggesting that these variables do not need to be controlled in the model.

3.4 Data Analysis Procedures

The data were analyzed using descriptive statistics, correlation analysis, and multiple linear regression. Initially, the normality of the variables was assessed to determine the most appropriate correlation analysis using the Shapiro-Wilk test (Razali & Wah, 2011). The results indicated that the distributions of the DIPNR [S-W(192) = 0.829; p = 0.000] and ISC [S-W(192) = 0.980; p = 0.008] variables significantly deviate from a normal distribution. Therefore, the Spearman's rho coefficient, a non-parametric procedure, was employed for the correlation analysis (Myers & Sirois, 2006).

The hypothesis testing was conducted using multiple linear regression analysis. Four models were estimated, represented by equations (4), (5), (6), and (7). This division is justified because the coefficients β_1 and β_2 from the estimations of equations (6) and (7) are conditional coefficients of their respective variables and are therefore not appropriate for testing hypotheses H1 and H2. Accordingly, the models in equations (4) and (5) aim to verify the direct effect of the predictor variables on the dependent variable, as proposed in hypotheses H1 and H2. Models (6) and (7) incorporate the moderating effect of the Sense of Control Index (ISC) on the sunk-cost effect in the explicit scenario (equation 6 model) and the implicit scenario (equation 7 model), as proposed in H3. The total sample was subdivided for model estimation. Models in equations (4) and (6) were estimated using observations from participants in the control group and the explicit scenario group (129 observations), while models in equations (5) and (7) were estimated using observations from participants in the control group and the implicit scenario group (127 observations). Regressions were estimated using the enter method, as the focus of this study is to explore the behavior of the predictor variables.

$$DIPNR = \beta_0 + \beta_1 ISC + \beta_2 ESC_{Exp} \quad (4)$$

$$DIPNR = \beta_0 + \beta_1 ISC + \beta_2 ESC_{Imp} \quad (5)$$

$$DIPNR = \beta_0 + \beta_1 ISC + \beta_2 ESC_{Exp} + \beta_3 ESC_{Exp} * ISC \quad (6)$$

$$DIPNR = \beta_0 + \beta_1 ISC + \beta_2 ESC_{Imp} + \beta_3 ESC_{Imp} * ISC \quad (7)$$

After estimating the models, their adherence to the following regression assumptions was assessed: randomness and independence of residuals (Durbin-Watson test), absence of multicollinearity (Variance Inflation Factor – VIF and Tolerance), normality of residuals (Shapiro-Wilk test), and absence of correlation between residuals and independent variables (homoscedasticity, tested via Breusch-Pagan) (Fávero & Belfiore, 2017). The Durbin-Watson statistics for the models were close to 2, indicating residual independence (Model 4: 1.936; Model 5: 1.822; Model 6: 1.931; Model 7: 1.821). No indications of multicollinearity were found, as Tolerance and VIF values for all variables were near 1 (Fávero & Belfiore, 2017). The Shapiro-Wilk test indicated that the residuals of all four models were not normally distributed, violating the normality assumption. To address this issue, bootstrapping was performed for the coefficients and their confidence intervals in all four models (Barker & Shaw, 2015), with 1,000 subsamples for Models 4 and 5 and 5,000 subsamples for Models 6 and 7. Heteroscedasticity was tested by estimating a regression model using the squared residuals as the dependent variable against the specified predictors of each model. Models 4 [F(2,126) = 2.022; p = 0.137] and 6 [F(3,125) = 2.293; p = 0.081] did not show heteroscedasticity issues, whereas Models 5 [F(2,124) = 14.658; p = 0.000] and 7 [F(3,123) = 10.413; p = 0.000] did. To correct for the violation of this assumption, bootstrap results were used for Model 5 (Williams et al., 2013) and Huber-White robust standard errors were applied for Model 7 (White, 1980).

4 RESULTS

4.1 Descriptive Statistics and Correlation Analysis

Considering the total sample, the DIPNR variable ranged from -5 to 5 (M = 1.9060; SD = 3.0871), while the ISC ranged from -2 to 2.75 (M = 0.6406; SD = 0.7143). Regarding the sunk-cost effect, 65 participants were assigned to the "explicit" scenario (33.9%), 63 to the "implicit" scenario (32.8%), and 64 (33.3%) to the control group ("neutral" scenario). Table 2 presents the descriptive statistics of the model variables, considering the sample division between the control group and the "explicit" scenario, and between the control group and the "implicit" scenario".

Table2

Descriptive Statistics – Subgroups

	"Neutral" vs. "Explicit" Scenario				"Neutral" vs. "Implicit" Scenario			
Variable	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation
DIPNR	-5	5	1.3720	3.3936	-5	5	1.6300	3.1315
ISC	-2	2.75	0.6802	0.6967	-1.25	2.75	0.6122	0.7425
ISC*$ESC_{Imp/Exp}$	-2	2	0.3508	0.5817	-1	2	0.2776	0.5953

Legend: DIPNR = Disposition to invest in non-profitable projects; ISC = Sense of Control Index; $ESC_{Imp/Exp}$ = Sunk-cost effect (implicit or explicit).
Source: Research data.

Spearman's correlation was calculated to assess the level of association among the model variables. Considering the total sample, the relationship between DIPNR and ISC was not statistically significant (r_s = -0,103; p = 0,156). In the sample containing only observations from the "neutral" and "explicit" scenarios, a statistically significant positive relationship was found between DIPNR and ISC*ESC_{Exp} (r_s = 0,199; p = 0,024) and ISC*ESC_{Exp} e ISC (r_s = 0,464; p = 0,000), while the relationship between DIPNR and ISC remained non-significant (r_s = -0,109; p = 0,220). In the sample containing only observations from the "neutral" and "implicit" scenarios,

the same pattern was observed, with a statistically significant positive relationship between DIPNR and ISC*ESC_{Imp}(r_s = 0,200; p = 0,025) and between ISC*ESC_{Imp} and ISC (r_s = 0,558; p = 0,000), while the relationship between DIPNR and ISC was also non-significant (r_s = -0,118; p = 0,188).

4.2 Regression model

Regression models were estimated to test the hypotheses (enter method) in order to assess the extent to which sense of control and the sunk-cost effect influence business students' willingness to continue investing in non-profitable projects. The F-test for model 4 (F(2,126) = 7,318; p = 0,001; R^2 = 0,104; $R^2_{Adjusted}$= 0,090) and model 5 (F(2,124) = 15,852; p = 0,000; R^2 = 0,204; $R^2_{Adjusted}$= 0,191) were statistically significant, indicating that at least one predictor variable in the models affected the dependent variable. Table 3 presents the coefficients for all predictors in the models from equations (4) and (5).

Table 3
Regression model: Direct effects

Predictors	Model 4				Model 5			
	Coefficients		t	Sig.	Coefficients		t	Sig.
	Beta	Standardized Beta			Beta	Standardized Beta		
(Constant)	0.408	-	0.837	0.404	0.610	-	1.459	0.147
ISC	-0.192	-0.039	-0.466	0.642	-0.495	-0.117	-1.460	0.147
ESC_{Exp}	2.171	0.321	3.807	0.000				
ESC_{Imp}					2.667	0.428	5.321	0.000

Legend: Dependent variable: DIPNR = Disposition to invest in non-profitable projects. Predictors: ISC = Sense of Control Index; ESC_{Exp} = Explicit sunk-cost effect; ESC_{Imp} = Implicit sunk-cost effect.
Source: Research data.

The results in Table 3 show that the presence of the sunk-cost effect, both in the implicit scenario (emphasis on project completeness) (β = 2.171; p = 0.000) and in the explicit scenario (emphasis on financial expenditure already incurred) (β = 2.667; p = 0.000), increased the willingness of business students to continue investing in non-profitable projects. Moreover, it was observed that the impact of the sense of control on this willingness was negative, but not statistically significant, in both the explicit scenario (β = -0.192; p = 0.642) and the implicit scenario (β = -0.495; p = 0.147). Table 4 presents the confidence intervals of the coefficients obtained from the bootstrapping procedure.

Table 4
Regression model: Bootstrapping

Predictors	Model 4		Model 5	
	Confidence Interval (β) [95%]	Sig.	Confidence Interval (β) [95%]	Sig.
(Constant)	[-0.621 to 1.591]	0.463	[-0.398 to 1.500]	0.245
ISC	[-1.370 to 0.709]	0.739	[-1.213 to 0.225]	0.187
ESC_{Exp}	[0.998 to 3.285]	0.002		
ESC_{Imp}			[1.688 to 3.637]	0.001

Legend: Dependent variable: DIPNR = Disposition to invest in non-profitable projects. Predictors: ISC = Sense of Control Index; ESC_{Exp} = Explicit sunk-cost effect; ESC_{Imp} = Implicit sunk-cost effect.
Source: Research data.

According to the information in Table 4, the interpretations of the coefficients in Table 3 remain consistent, as the confidence intervals for the variables ESC_{exp} and ESC_{Imp} are positive and do not include zero, whereas the confidence intervals for the ISC variable in both models include zero. This indicates a positive effect of the presence of the sunk-cost effect and no effect of the sense of control on the dependent variable. Table 5 presents the moderation analysis conducted to investigate whether the sense of control can amplify or weaken the effect of the sunk-cost presence on business students' willingness to continue investing in non-profitable projects.

Table 5
Moderation Regression Model

	Model 6				Model 7			
Predictors	Coefficient (β)	Standard Error	t	Sig.	Coefficient (β)	Standard Error	t	Sig.
(Constant)	0.681	0.546	1.248	0.214	0.681	0.623	1.092	0.277
ISC	-0.602	0.551	-1.091	0.277	-0.602	0.659	-0.914	0.363
ESC_{Exp}	1.544	0.801	1.928	0.057				
ESC_{Imp}					2.537	0.660	3.841	0.000
$ESC_{Exp} * ISC$	0.920	0.826	1.114	0.267				
$ESC_{Imp} * ISC$					0.213	0.734	0.290	0.772

Legend: Dependent variable: DIPNR = Disposition to invest in non-profitable projects. Predictors: ISC = Sense of Control Index; ESC_{Exp} = Explicit sunk-cost effect; ESC_{Imp} = Implicit sunk-cost effect; $ESC_{Exp} * ISC$ = interaction between the Control Sense Index and the explicit sunk-cost effect; 〖ESC〗 _Imp*ISC = interaction between the Control Sense Index and the implicit sunk-cost effect.
Source: Research data.

The model results indicate that the interaction between the sunk-cost effect and the Control Sense Index was not statistically significant, both in the explicit scenario (β = 0.920; p = 0.267) and in the implicit scenario (β = 0.213; p = 0.772). To ensure greater robustness of the coefficients obtained, bootstrapping was performed with 5000 subsamples (Table 6).

Table 6
Regression Model: Moderating effect (bootstrapping)

	Model 6			Model 7		
Predictors	Coefficient (β)	Standard Error	Confidence Interval (β) [95%]	Coefficient (β)	Standard Error	Confidence Interval (β) [95%]
(Constant)	0.702	0.636	[-0.541 to 1.931]	0.692	0.636	[-0.542 to 1.968]
ISC	-0.612	0.671	[-1.903 to 0.720]	-0.599	0.672	[-1.904 to 0.702]
ESC_{Exp}	1.660	0.975	[-0.239 to 3.631]			
ESC_{Imp}				2.530	0.672	[1.196 to 3.809]
$ESC_{Exp} * ISC$	0.766	1.067	[-1.449 to 2.726]			
$ESC_{Imp} * ISC$				0.213	0.748	[-1.271 to 1.654]

Legend: Dependent variable: DIPNR = Disposition to invest in non-profitable projects. Predictors: ISC = Sense of Control Index; ESC_{Exp} = Explicit sunk-cost effect; ESC_{Imp} = Implicit sunk-cost effect; $ESC_{Exp} * ISC$ = = interaction between the Control Sense Index and the explicit sunk-cost effect; 〖ESC〗 _Imp*ISC = interaction between the Control Sense Index and the implicit sunk-cost effect.
Source: Research data.

The results in Table 6 support the interpretations from Table 5, as the confidence interval for the coefficient of the interaction between the sunk-cost effect and the Sense of Control Index includes zero, indicating the absence of a moderating effect.

4.3 Discussion of the results

The **first hypothesis** posited that the presence of the sunk-cost effect would positively impact business students' willingness to invest in non-profitable projects. Based on the means of the DIPNR variable across the different groups and the statistically significant positive coefficients of the ESC_{Exp} and ESC_{Imp} in models 4 and 5, t**he hypothesis was NOT rejected**.

The results of this study indicate that, on average, business students were willing to continue investing in the hypothetical investment project, regardless of the experimental scenario presented, and that previously incurred costs expressed both in terms of project completeness and financial resources increased this willingness compared to the control group (neutral scenario). These findings align with previous empirical studies on the topic (Rover et al., 2009; Silva & Domingos, 2010; Altoé et al., 2013; Meireles et al., 2019; Paraboni et al., 2019; Santos et al., 2021), reinforcing the notion that the formal knowledge acquired during the academic training of these students does not sufficiently equip them with the technical skills to identify and mitigate heuristic biases, particularly the sunk-cost effect. Further evidence supporting this argument is that no significant effects of the students' course or semester were found on the dependent variable, indicating that the median willingness to invest in these projects is statistically equivalent across different courses and stages of study.

However, from a theoretical perspective, this insufficiency is expected, as susceptibility to these heuristic biases is considered an inherent aspect of human cognition (Rover et al., 2009; Nobre et al., 2022). Given that intuitive and automated analysis is naturally prioritized by human cognition in judgment processes, that decisions involving sunk costs entail uncertainty and, therefore, risk, and that exposure to risk tends to trigger automatic responses in agents (e.g., loss aversion, regret aversion, self-protection of reputation) (Arkes & Blumer, 1985; Friedman et al., 2007; Silva et al., 2024), which are valued and considered in decision-making, it is unlikely that isolated formal interventions (e.g., presenting the concept of the sunk-cost effect in undergraduate courses) are sufficient to counteract this entire cognitive structure. Therefore, considering the adverse effects heuristic biases may have in organizational contexts, we recognize the importance of investigating the sunk-cost effect, but we understand that psychological or emotional constructs may represent a more appropriate strategy to mitigate or eliminate this phenomenon, aiming to "counter it" through the same mechanisms by which it operates (automated processes intrinsic to human cognition). The investigation of the sense of control represents an initial effort in this direction.

The **second hypothesis** posited that individuals with a higher sense of control would exhibit a greater willingness to invest in non-profitable projects. Based on the Spearman correlation results and the non-significant coefficients of the ISC variable in models 4 and 5, **the hypothesis was rejected.**

The results of this study indicated a non-significant negative association between sense of control and the willingness to invest in non-profitable projects. Furthermore, the shared variance between these variables was very low, suggesting that their joint behavior bears no meaningful relationship, either directly or indirectly (in the context of the presence of heuristic biases). These findings contradict theoretical expectations, as it was anticipated that individuals with a higher sense of control would overestimate their ability to influence the future outcome of an investment with low expected returns.

The absence of any relationship between sense of control and the sunk-cost effect, as well as its consequences, may suggest that psychological constructs and concepts anchored in an

individual's perception of certain traits may not be adequate to counteract phenomena embedded in the structure of human cognition, as is the case with the sunk-cost effect. For example, Rogge (2021) found evidence suggesting that autistic individuals are less susceptible to the sunk-cost effect. Therefore, considering the structural nature of biases in human cognition, psychological characteristics conceptualized from beliefs, such as sense of control, may not be crucial in this context, even though they tend to foster favorable behaviors, such as greater self-confidence (Wu & Hao, 2007), higher adaptability (Duffy, 2010), and preference for long-term rewards (He et al., 2019).

The **third hypothesis**, in turn, posited that the influence of the sunk-cost effect on the willingness to invest in non-profitable projects would be greater for individuals with a higher sense of control than for those with a lower sense of control. Based on the non-significant relationship between the interaction of the Sense of Control Index and the sunk-cost effect (in both the explicit and implicit scenarios), **the hypothesis was rejected**.

The results indicate that there is no empirical basis to assert that individuals with a higher sense of control are more likely to experience the effects of sunk costs more intensely in their decision-making process. Thus, theoretical mechanisms related to sunk costs (e.g., loss aversion, waste aversion, and the certainty effect) (Arkes & Blumer, 1985; Friedman et al., 2007) may be experienced similarly by individuals in these situations, regardless of their sense of control. In this regard, the findings are consistent with prior literature concerning the "universality" of this decision-making bias across different populations (Meireles et al., 2019; Paraboni et al., 2019; Rengel et al., 2019; Santos et al., 2021). Furthermore, this independence from personal characteristics reinforces the current understanding that heuristic biases are an inherent part of human intuitive thinking and decision-making processes, which are employed when complete processing of available information is impractical or inaccessible (Rover et al., 2009; Nobre et al., 2022).

5 CONCLUSION

This study aimed to analyze the impact of the sense of control on the influence of the sunk-cost effect on the willingness to invest in unprofitable projects. The research was operationalized through a quasi-experiment and analyzed using multiple linear regression models, which allowed for an empirical examination of the relationship and interaction between the variables collected.

The findings suggest the need to enhance the technical training of business students, particularly regarding strategies for teaching economic rationality, given the evidence of biased decisions regardless of the presence or absence of the sunk-cost effect in the hypothetical scenario. Considering the intrinsic nature of this phenomenon within human cognition, the study proposes that strategies beyond mere exposure to the concept should be encouraged to mitigate the effects of heuristic biases on students' decision-making processes. This approach can be useful both for understanding the functioning of the sunk-cost effect and for the development of future managers, accountants, economists, and related professionals. The results underscore the importance of interdisciplinary integration in business education to foster greater awareness among students of how cognitive biases, especially the sunk-cost effect, can influence financial decisions. It raises the question of whether active learning methodologies, such as problem-based learning, may be appropriate in this context across different temporal horizons.

Although the sense of control did not prove to be significant in relation to the sunk-cost effect, this article is believed to contribute to the literature by experimentally exploring variables that may mitigate the impact of heuristic biases on financial investment decision-making. The present study demonstrates that the influence of these biases should not be underestimated and that even if desirable skills are developed in decision-makers, this does not necessarily reduce their propensity to engage in biased decisions. In the business context, these findings underscore the

importance of implementing and maintaining formal decision-making mechanisms, whether through managerial control tools or economic techniques for investment evaluation.

As a limitation of the present study, the geographic restriction of the target population is noted, as well as the fact that it was not verified whether the expected positive outcomes of a high sense of control were actually present in individuals with elevated sense-of-control scores. Furthermore, there is the limitation regarding the representativeness of the experimental scenario used to manipulate the "sunk-cost effect" variable, which does not encompass the full informational complexity of real business practice, and the target population consisted solely of students. It is suggested that this study be replicated with market professionals. Additionally, future research could examine the direct and mediating effects of variables derived from the sense of control (e.g., adaptability, preference for long-term rewards) on the incidence of heuristic biases, as well as explore the predictive function of psychological variables related to the structure of human cognition. Moreover, it is recommended to investigate the impact of incorporating active learning methodologies aimed at teaching these biases on students' ability to identify and mitigate such heuristics over time.

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APPENDIX A – Data Collection Instrument: Experimental Task

Source: Adapted from Domingos (2007)

SCENARIO: Implicit

Imagine that you are the VICE PRESIDENT of a company. You had a budget of 10 million reais allocated for research to build a bio-oil powered car. When the project is 90% complete, another company launches marketing for a bio-oil powered car as well. The competitor's car is much faster and more efficient than your company's car. Considering the scenario above, on a scale from -5 to 5, what is your willingness to invest the next 1 million of the research budget in the project?

-5 = I Absolutely Would Not Invest 5 = I Absolutely Would Invest

Note: CIRCLE your choice (Select only ONE)

-5 -4 -3 -2 -1 0 1 2 3 4 5

SCENARIO: Explicit

Imagine that you are the VICE-PRESIDENT of a company. You had a budget of 10 million reais allocated to research to build a bio-oil powered car. When 9 million reais have already been spent, another company launched marketing for a car also powered by bio-oil. The competitor's car is much faster and more efficient than your company's car. Given the scenario above, on a scale from -5 to 5, what is your willingness to invest the next 1 million of the research budget in the project?

-5 = I Absolutely Would Not Invest 5 = I Absolutely Would Invest

Note: CIRCLE your choice (Select only ONE)

-5 -4 -3 -2 -1 0 1 2 3 4 5

SCENARIO: Neutral

Imagine that you are the VICE PRESIDENT of a company. You received a suggestion from one of your employees to use 1 million reais from your research budget to develop a bio-oil powered car. However, another company has already started marketing a bio-oil car, and the competitor's car is much faster and more efficient than the one your company could build. Given the scenario above, on a scale from -5 to 5, what is your willingness to invest the next 1 million of the research budget in the project?

-5 = I Absolutely Would Not Invest 5 = I Absolutely Would Invest

Note: CIRCLE your choice (Select only ONE)

-5 -4 -3 -2 -1 0 1 2 3 4 5

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding this submitted work.

AUTHOR CONTRIBUTIONS

Roles	1st author	2nd author	3rd author	4th author	5th author
Conceptualization	♦	♦	♦	♦	♦
Data curation	♦				
Formal analysis	♦				
Funding acquisition		♦	♦		
Investigation	♦	♦			
Methodology			♦		
Project administration	♦	♦			
Resources	Não possui				
Software	♦				
Supervision		♦			
Validation	♦	♦	♦	♦	♦
Visualization	♦				
Writing – original draft	♦				
Writing – review and editing	♦	♦	♦	♦	♦