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Are Decision Makers Rational in Ambiguous Situations?

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Abstract: *This research work analyzes human behavior in complex situations and explains how decisions makers act in ambiguous situations.*

The objective of this research work is to study the sunk cost effect and the completion percentage effect of an investment project in a decision-making process. This research work uses a “retrospective rationality” approach to justify irrational behaviors such as the sunk cost effect, the completion percentage effect of an investment project and the irrational escalation since decision-makers are repeatedly affected by the decisions on past irreversible investments.

This research work evaluates three sunk cost levels, and three completion percentage levels of an investment project, besides three neutral situations in a business environment and a personal decision situation. Graduate students in three Portuguese Management Schools responded to the questionnaires.

Model results show that the value of resources invested is crucial for understanding the students’ rational behavior, who participated in this research work. These results disclose statistical evidence that the information on sunk costs and completion percentage of an investment project determines human behavior under irrational escalation in ambiguous situations. As a consequence, decision makers have the opportunity to interpret their decisions, since the scenarios do not allow a unique definition of rational choice, it is not correct to judge the irrational decision makers that decide to continue to invest in ambiguous situations.

Keywords: *Human Behavior, Sunk costs Effect, Completion Percentage Effect of an Investment Project, Irrational Escalation, Ambiguous Situations.*

JEL Classification: C12, D80, G10

1. INTRODUCTION

This research work studies the sunk cost effect and completion percentage effect of an investment project in a decision-making process (Domingos, 2007; and, Silva, 2010). The “retrospective rationality” approach is applied to justify irrational behaviors such as the sunk cost effect, the completion percentage effect of an investment project and the irrational escalation since decision-makers are repeatedly affected by the decisions on past irreversible investments (Ponte and Bonifacio, 2004).

Ambiguous situations are those in which there is a lack of meaning since there is no sufficient information to formulate a unique frame that helps us to interpret events and find probabilities (Cohen, March, and Olsen, 1972; March and Olsen, 1976; and, Hatch, 1997). This research work shows that the higher the ambiguity of the decision context, the more people will escalate and provide some data to sustain the incidence of the irrational escalation in a decision-making process. The problem statement is what factors determine the incidence of the irrational escalation in a decision process.

The overall objective is to describe the irrational escalation through the factors which determine their occurrence. This objective has three specific objectives. The first one is to verify the importance of the sunk cost effect on irrational escalation. The second one is to check the importance of the completion percentage effect of an investment project on irrational escalation. The last one is to analyze the effect of some factors on irrational escalation.

This article has the following chapters. The next one presents literature review. The third one explains the methodology. The fourth one describes the data and information. The fifth one analyzes and discusses results. The last one presents conclusions.

2. LITERATURE REVIEW

Modern Finance Theory and Behavior Finance help us to understand the decision-making process. Modern Finance theory assumes that markets are perfectly stable, and decision makers are rational (McMahon, 2005; Statman, 1999; Rabin, 1998; Slovic, Fischhoff, and Lichtenstein, 1977; and, Thaler, 1999). Their predictions might not characterize decision makers' behavior. Research works have shown there exist violations of their assumptions.

Behavior Finance analyzes decision makers' behavior in financial situations considering the violations of rational choices and looking for understanding the psychology behind these alternatives. The understanding of the decision process has permitted to explain the judgment errors such as conjunction fallacy, escalation of commitment, commitment bias, base rate error, excessive optimism, illusion of control (McMahon, 2005; Tversky and Kahneman, 1981; Tversky and Kahneman, 1986; Rabin, 1998; and, Slovic, Fuschhoff, and Lichtenstein, 1977; and, Macaskill, and Hackenberg, 2012).

Sunk costs are retrospective costs already incurred, and cannot be recovered (Garrison, Noreen, and Brewer, 2012; Martin, 2002; Wang and Yang, 2001; Park, and Jang, 2014; and, Balasubramanian, Kalyanasundaram, and S, 2016). Modern Finance Theory considers that sunk costs are not relevant in a decision-making process. Sunk costs cannot be used to make decisions about future events. Only revenues and costs should be necessary to allocate resources (Atkinson et al., 2001; and Garrison, Noreen, and Brewer, 2012). We should ignore Sunk costs when decision makers choose among future alternatives.

Sunk costs do not only have an economic meaning, but they also have a psychological sense (Luther, 1992). If an investment project is almost completed and there are negative feedbacks, the tendency is to continue increasing investment (Keil, Mann, and Rai, 2000; and, Kelly, and Milkman, 2013). The commitment of decision maker for continuing with negative information produce uncertainties when objectives are reached.

Irrational escalation refers to a situation in which decision makers can make irrational decisions based upon rational decisions in the past or to justify actions already taken which depend on two critical variables (Keil, Truex, and Mixon, 1995; and, Staw, and Ross, 1989), that is, sunk cost effect and completion percentage effect of an investment project. The first one is the sunk cost effect on the value of resources already invested. In this case, the decision maker assumes a commitment to continue investing in an attempt to reverse the negative situation. The second one is the completion percentage effect of an investment project and means how much an investment project is close to being completed (Keil, Truex, and Mixon, 1995; and, Buxton, and Rivers, 2014).

Research studies have shown that the existence of personal responsibility increases sunk cost effect, and the non-existence decreases it, but it does not disappear. This statement is consistent with the Prospect Theory and, decision makers have difficulty in accepting a wrong decision and a mistaken when they make a choice. The closer is the completion of the project, the greater the desire to continue investing. The study of sunk cost effect and completion percentage effect of an investment project is necessary to understand their effects on irrational escalation (Domingos, 2007; Silva, 2010; and, Bonifacio and Ponte, 2006).

3. METHODOLOGY

This research work uses Domingos' and Silva's approaches, which use three different investment scenarios characterized by increasing levels of interpretability in each one of the questionnaires. We present one of these scenarios below:

“As the president of a company, you have invested 10 million Euros of the company's money into a research project. The purpose was to develop an electric car. When the project is 90% completed, another company begins marketing an electric car that is much faster and far more economical than the car your business could build. The question is: should you invest the last 10% of the research funds to finish your electric car?” (Scenario adapted from a study developed by Arkes and Blumer, 1985).

Statistical tests are used to verify whether variances are equal or different among to various questionnaires and to determine whether there are significant differences among their means, which

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require the hypotheses formulation and the use of the t-test for variance and the t test for means and the Chi-square test for differences in two proportions (Levine, Stephan, Krehbiel, and, Berenson, 2008). The null hypotheses are the following:

H₀: the variance of the willingness of the respondents of the questionnaires A, B, C, AA, BB and CC is equal to the variance of the willingness of respondents of the questionnaires A.1, B.1, and C.1;

H₀: the mean of the willingness of the respondents of the (A, B, C) or (AA, BB, and CC) questionnaires is equal to the mean of the willingness of the respondents of the A.1, B.1, and C.1 questionnaires; and,

H₀: the observed frequency of the incidence of the irrational escalation of the respondents of the (A, B, C) or (AA, BB, and CC) questionnaires is equal to the observed frequency of the incidence of the irrational escalation of the respondents of the A.1, B.1, and C.1 questionnaires. All tests use a 0.05 level of significance.

4. DATA AND INFORMATION

This research work uses four questionnaires to collect data and information. Three of these questionnaires include a scenario and respondent's information such as sex, age, institution and graduate program. The respondent's information was adapted from the research works of Carpenter, Matthews and Brown (2005), Domingos (2007), and Silva (2010). Each one of these questionnaires includes a scenario, where the respondent assumes the role of the vice-president of a corporation, and he is responsible for a budget of ten million Euros to develop an electric car. In addition to these three types of questionnaires, it was also developed one questionnaire to capture the sunk cost effect on the resource allocation process involving a personal decision, so that we can assess whether the environment, in which the decision maker is inserted, interfere in their decisions (Tan and Yates, 1995). The participant has to choose to travel to the Azores (questionnaire I), and he paid 1,500.00 Euros, while the travel to Madeira (questionnaire II) was won in a contest show, that is, there was no payment. However, there is a perception that the travel to Madeira will be more fun. The neutral version (questionnaire II) does not have any value and the perception that the free travel will be more fun remains. The answer to this questionnaire is the choice between the travel to the Azores or Madeira.

Table 1. Questionnaires Types

Questionnaire Type	Scenarios	Information
% Completion	A	90% completed
	B	50% completed
	C	10% completed
Sunk cost	AA	9 million invested
	BB	5 million invested
	CC	1 million invested
Neutral	A.1	No investment value
	B.1	No investment value
	C.1	No investment value
Personal decisions	I	Paid holiday
	II	No paid holiday

Three hundred and twenty graduate students of three Portuguese Management Schools participated voluntarily in this research work (Grejo, Faia, and Abbas, 2015). The institutions were one University and two Polytechnic Institutes. Every participant was asked to respond to a random questionnaire (Table 1).

Table 2 presents the sampling distribution of the questionnaires.

This analysis of the data collected by sex shows that the sample has 44.6% of males and 55.4% of females. There are two age groups. The first one with age above 21 years old represents 41.6% of the sample, while the second one with age equal or under 21 years old is about 58.4% of the sample. The University and the two Polytechnic Institutes represent 48.5% and 51.5% of the sample. The Accounting and Finance graduate students and other graduate students in both institutions represent 49.5% and 50.5% of the sample, respectively.

Table2. *Sampling Distribution of Questionnaires*

Questionnaires	Sample	%
A	31	11.57
B	27	10.07
C	30	11.19
A.1	30	11.19
B.1	29	10.82
C.1	29	10.82
AA	31	11.57
BB	28	10.45
CC	28	10.45
Subtotal	263	82.19
I	28	49.12
II	29	50.88
Subtotal	57	17.81
Total	320	100.00

Source: *Author's results*

5. RESULTS

This chapter has three sections. The first one analyzes the sunk cost effect of an investment project on irrational escalation. The second one discusses the completion percentage effect of an investment project on irrational escalation. The last one describes the sunk cost effect in the resource allocation process involving personal decisions.

5.1. The Sunk Cost Effect of an Investment Project on Irrational Escalation

The statistical analysis of sunk cost effect by the median shows that the willingness of respondents to AA, BB and, CC scenarios is high because the values of median are not below 90% (Table 3).

Table3. *Sunk Cost Effect – Statistical Analysis*

Questionnaires	n	Mean	Median	σ
AA	31	67.61	100	7.57
BB	28	71.14	90	7.07
CC	28	72.32	100	8.19
A.1	30	52.21	50	8.19
B.1	29	53.42	60	7.82
C.1	29	61.03	80	7.82

Source: *Author's results*

Note: σ – *Standard Deviation*

The willingness of respondents for A.1, B.1, and C.1 scenarios decreases and the median values are below 90%, and the investment value is not known. There is evidence that the disclosure of the investment value determines the incidence of the sunk cost effect. Although the median values are high, above 50, and, the statistical dispersion of data is not high. Furthermore, the median values are not gathered close to the mean, except A.1 and B.1 cases. The statistical dispersion can be justified by the high incidence of extreme values (0 to 100), with few common responses. On the sunk cost effect, we can see that the mean values are high. This situation indicates the willingness of respondents to continue investing in a project that has negative feedback. The means values of the neutral questionnaires show that the higher the value of resources to be used in an investment project, the greater the willingness of decision makers to invest in the development of the investment project.

Table4. *Sunk Cost Effect – The t test for mean*

Questionnaires	t	p
AA X A.1	-3.215	0.001
BB X B.1	-3.843	0.000
CC X C.1	-2.095	0.020

Source: *Author's results*

Note: *t-test and p-value*

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We can see where the information of the value already invested, the average of responses was higher than that obtained in a neutral scenario. When no data are available for the value of resources already invested, the average of responses to investing is lower. We need to know whether these differences among means are significant. It was conducted the test for mean for a 0.05 significance level (Table 4). The test results show that the null hypothesis that the means values are equal is rejected. Therefore, the value of resources already invested determines the incidence of the sunk cost effect, because the differences among the means are significant. The information of sunk costs is relevant in the incidence on irrational escalation since it was found significant differences among means.

Table 5. *Sunk Cost Effect – Frequencies*

Respondents		> 50		≥ 50	
		yes	%	yes	%
AA	31	21	66.34	23	75.34
BB	28	18	70.51	22	79.04
CC	28	20	72.78	21	76.55
A.1	30	14	47.76	18	61.43
B.1	29	15	51.31	18	62.49
C.1	29	17	57.08	21	71.21

Source: *Author's results*

Regarding the impact of the sunk cost effect, the AA scenario, where 9 million euros were invested, 66% of people surveyed invest more resources, while the neutral A.1 scenario does not reach 50%, as shown in Table 5. In this case, the disclosure of the information of sunk cost proved to be significant in the incidence of the sunk cost effect.

The null hypothesis that the means values are equal is rejected. The results show that investment value is relevant in the incidence of the sunk cost effect. There are significant differences among means values.

Table 6. *Sunk Cost Effect – Analysis of Factors*

Questionnaires	Sex	Age	Institution	Program
AA	$\chi^2 = 0.128$ t = 0.734	$\chi^2 = 2.773$ t = 1.314	$\chi^2 = 0.312$ t = 0.022	$\chi^2 = 1.011$ t = 0.583
BB	$\chi^2 = 0.363$ t = -0.315	$\chi^2 = 0.003$ t = 0.143	$\chi^2 = 2.362$ t = 2.032	$\chi^2 = 0.521$ t = 1.342
CC	$\chi^2 = 0.038$ t = -0.364	$\chi^2 = 0.367$ t = 0.336	$\chi^2 = 3.165$ t = -1.332	$\chi^2 = 0.051$ t = 0.375
A.1	$\chi^2 = 1.353$ t = -0.645	$\chi^2 = 0.174$ t = -0.197	$\chi^2 = 0.643$ t = -1.078	$\chi^2 = 0.001$ t = 0.113
B.1	$\chi^2 = 0.191$ t = 0.102	$\chi^2 = 0.217$ t = 1.022	$\chi^2 = 1.017$ t = 0.533	$\chi^2 = 0.033$ t = 0.003
C.1	$\chi^2 = 2.322$ t = -1.521	$\chi^2 = 4.521^{**}$ t = 2.121 ^{**}	$\chi^2 = 4.801^{**}$ t = -1.346	$\chi^2 = 5.013^{**}$ t = 2.235 ^{**}

Source: *Author's results*

We present the results of hypothesis testing for the factors in Table 6. These results show that there are no significant behavior differences between men and women in all kinds of questionnaires. The age and institution factors, only in the C.1 neutral scenario, are significant for the sample. Moreover, the accounting and financial graduate students show behavior different from other graduate students in the C.1 questionnaire used to capture the sunk cost effect.

5.2. The Completion Percentage Effect of an Investment Project on Irrational Escalation

The statistical analysis of completion percentage effect of an investment project by the median values shows that the willingness of respondents for A, B, and C scenarios is high because their median values are not below 80% (Table 7). The A.1, B.1, and C.1 questionnaires, in which the information of completion percentage of an investment project is not presented, show that the willingness of the

respondents is lower, except in the C.1 questionnaire with 80%. The results show that the completion percentage effect of an investment project is above 60% which indicates a willingness of the respondents to continue investing in an investment project that has a scenario not favorable. The willingness increases when the project is over close to completion. The average of the responses for 90% of the investment project is higher than the 50% case. The A.1, B.1, and C.1 questionnaires show that the higher the value of resources to be invested, the greater the willingness of decision makers to invest in the analyzed investment project. When the completion percentage of an investment project was highlighted, the willingness of respondents to continue investing was higher. This situation suggests that the completion percentage of an investment project is crucial for the incidence on irrational insistence.

Table 7. Completion Percentage Effect – Statistical Analysis

Questionnaires	n	Mean	Median	σ
A	31	70.12	100	7.45
B	27	66.35	80	6.41
C	30	61.32	90	7.67
A.1	30	52.21	50	5.19
B.1	29	53.42	60	5.82
C.1	29	61.03	80	5.82

Source: Author’s results

Note: σ – Standard Deviation

Table 8. Completion Percentage Effect – The t test for mean

Questionnaires	t	p
A X A.1	4.162	0.001
B X B.1	2.904	0.000
C X C.1	0.055	0.651

Source: Author’s results

Note: t-test and p-value

The null hypothesis that the means values are equal is rejected except to the CxC.1 questionnaires (Table 8). The completion percentage of 90% and 50% for an investment project is relevant in the incidence on irrational escalation, and it was found significant differences among their means values.

Table 9. Completion Percentage Effect – Frequencies

Participants		> 50		≥ 50	
		yes	%	yes	%
A	31	22	70.11	24	79.23
B	28	18	65.03	22	78.48
C	28	16	58.54	19	69.37
A.1	30	14	47.76	18	61.43
B.1	29	15	51.31	18	62.49
C.1	29	17	57.08	21	71.21

Source: Author’s results

The frequency analysis for irrational insistence is displayed in Table 9. This analysis shows that 70% of the sample continues investing in the A questionnaire, while only 48% would continue investing in the A.1 scenario. The completion percentage of an investment project is significant in the incidence on irrational escalation, and it was rejected for the 5% significant level. When the project is only 10% complete, 58.5% acts irrationally, and the C.1 questionnaire represents 53.4 % of the sample. The disclosure of the completion percentage of 10% for an investment project does not have any effect on the incidence of irrational insistence, and it was not rejected for the 0.05 significant level.

We present the results of hypothesis testing performed for the analysis of factors in this research work in Table 10. These results show that no significant behavioral differences between men and women in all types of questionnaires. The age and institution factors were only significant for the sample in the C.1 scenario. Finally, graduate students in accounting and finance behave differently from other graduate students in the C.1 questionnaire used to capture the completion percentage effect of an investment project.

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Table 10. Completion Percentage Effect – Analysis of Factors

Questionnaires	Sex	Age	Institution	Program
A	$\chi^2 = 2.353$ t = -1.032	$\chi^2 = 1.015$ t = 0.435	$\chi^2 = 0.292$ t = 0.107	$\chi^2 = 1.133$ t = 0.442
B	$\chi^2 = 0.212$ t = 0.078	$\chi^2 = 4.013^{**}$ t = -2.003**	$\chi^2 = 1.471$ t = 1.153	$\chi^2 = 0.098$ t = 0.687
C	$\chi^2 = 1.255$ t = 1.177	$\chi^2 = 1.124$ t = -0.311	$\chi^2 = 1.463$ t = 0.691	$\chi^2 = 0.167$ t = 0.146
A.1	$\chi^2 = 1.353$ t = -0.645	$\chi^2 = 0.174$ t = -0.197	$\chi^2 = 0.643$ t = -1.078	$\chi^2 = 0.001$ t = 0.113
B.1	$\chi^2 = 0.191$ t = 0.102	$\chi^2 = 0.217$ t = 1.022	$\chi^2 = 1.017$ t = 0.533	$\chi^2 = 0.033$ t = 0.003
C.1	$\chi^2 = 2.214$ t = -1.521	$\chi^2 = 4.672^{**}$ t = 2.215**	$\chi^2 = 4.931^{**}$ t = -1.552	$\chi^2 = 4.289^{**}$ t = 2.663**

Source: Author's results

5.3. The Sunk Cost Effect on Personal Decisions

A questionnaire was used. Fifty-seven participants answer to the questionnaires (Table 2). Twenty-eight participants answer to the questionnaire I, and 61.4% decided not to throw away the money that they already paid for the Azores holiday, although Madeira holiday was much more fun and desirable. Twenty-nine participants answer to the questionnaire II, and 52.4% decided to travel to the Azores because they had already paid for the Azores holiday package. We can conclude that the cost of 1500 Euros does not have influence in the irrational escalation. 37% of the University students decided to travel to the Azores, while 52% of Polytechnic students decided to travel to the Azores. Polytechnic students are more sensitive to irrational escalation than University students.

6. CONCLUSIONS

The Modern Financial Theory states that sunk costs should not be considered in the decision-making process. This situation does not happen in real life, and decision makers have a different behavior.

Model results confirm the sunk cost effect and the percentage completion effect of an investment project on the incidence of irrational escalation. The sunk cost effect (1, 5 and 9 million Euros) have an impact on the incidence of irrational escalation. The completion percentage of 50% and 90% of an investment project has an impact on the incidence of irrational escalation.

The analysis of factors shows that females are more sensitive than males, as well as the graduate students in Accounting and Finance, Polytechnic Institutes students and, students with age below 21 years old. These results help us to reinterpret the irrational escalation since the scenarios used to analyze such behavior were made in ambiguous situations. As a consequence, decisions makers can interpret the decision scenarios in different ways since the scenarios do not allow a unique definition of rational choice it is not correct to judge necessarily irrational decision makers that decide to continue investing in ambiguous situations. Some insight that ambiguity influences a constructive willingness to commit further resources to ongoing projects despite negative feedbacks is found in the scenarios we have done to analyze the relationship of sunk cost effect and completion percentage effect of an investment project on irrational escalation.

Further research should be done how sunk cost and completion percentage of an investment project affect irrational escalation, using more robust quantitative approaches and a more theoretical base.

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